Popular Science®

The What's New magazine

$1.50
SEPTEMBER
1982

Here at last:
low-cost
DIY SOLAR HEATERS

Checking out a
FEEDBACK
CARBURETOR

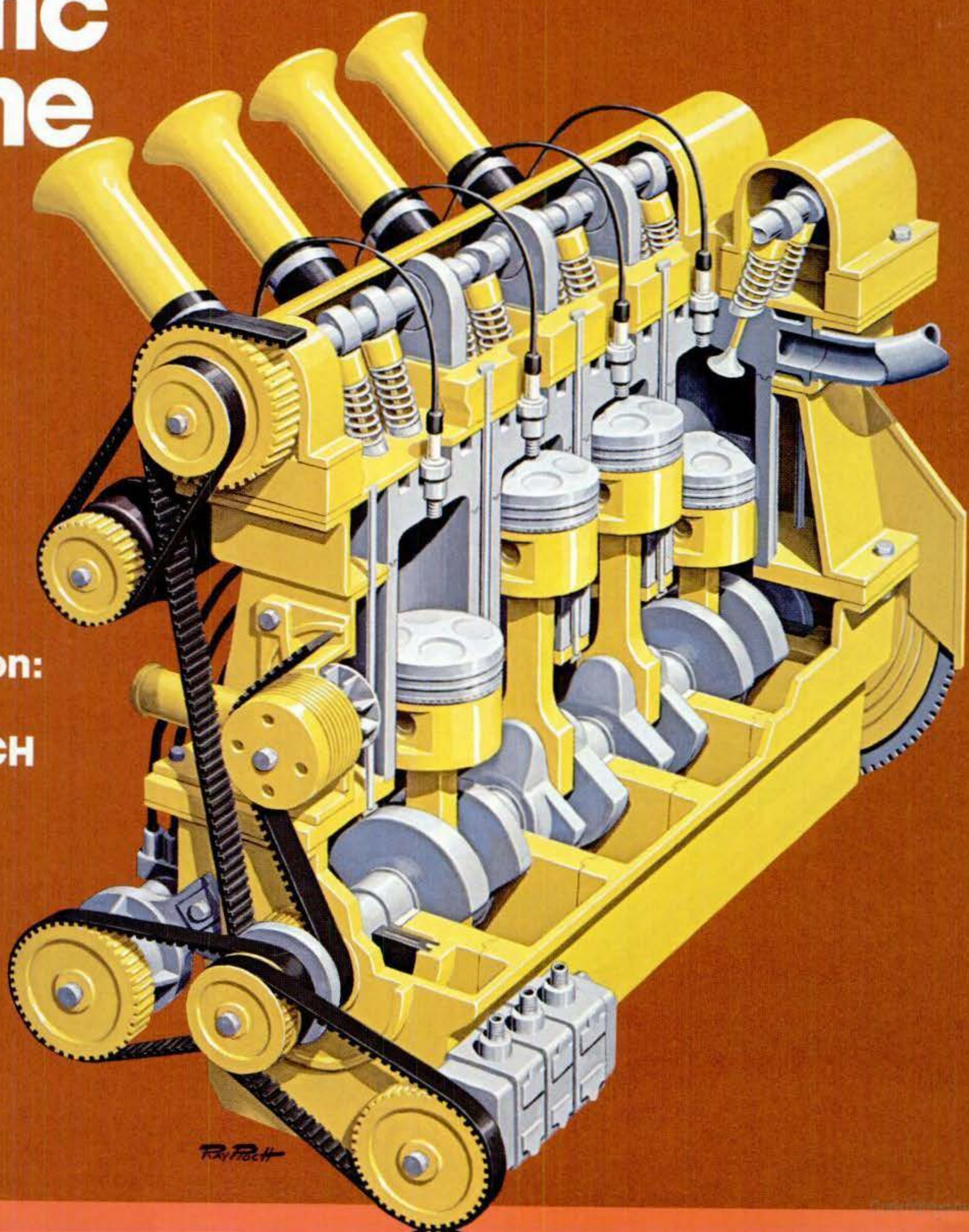
Ford's impossible
plastic engine

TALKING
APPLIANCES

THE GLASS-
WIRED
COMMUNITY

Now: 96%
efficient
PULSE-
COMBUSTION
FURNACE

Special section:
STORAGE
FROM SCRATCH
- Living-dining divider
- Storage wall
- Wine cellar
- Swing-out shelves



09
726597

Will the real lowest tar

2 mg **4 mg** **3 mg** **7 mg** **5 mg**

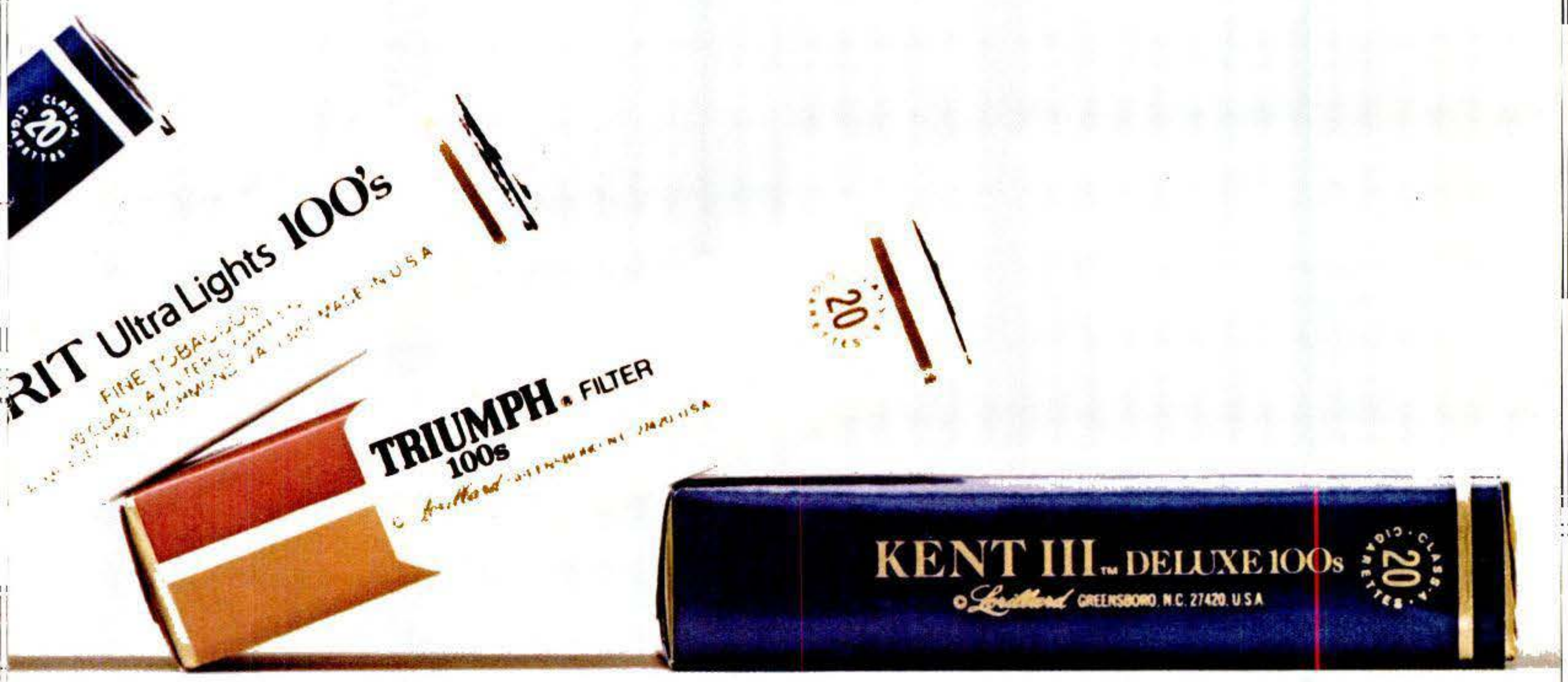
NOW

Competitive brand tar levels reflect the lower of either FTC method or Dec. '81 FTC Report.

SOFT PACK 100's FILTER, MENTHOL: 2 mg. "tar", 0.2 mg. nicotine, av. per cigarette by FTC method.

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

100's please stand up?



4 mg 4 mg

The Lowest

The lowest in tar of all brands.

CONFIRMED BY LATEST U.S. GOV'T. REPORT ON TAR

This One

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Popular Science MONTHLY®
The What's New magazine

SEPTEMBER 1982
Founded in 1872/Vol. 221, No.3

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Ford's impossible plastic engine
At just 152 lbs. it puts out 318 hp, has a maximum speed of 14,000 rpm. PAGE 71

Low-cost, efficient kit solar heaters
Modular DIY panels are mass-produced at a quarter of the usual price. PAGE 64

Talking appliances—those new voices in your life
From calculators to clocks, silicon chips give them the power of speech. PAGE 74

Now: 96% efficient pulse-combustion furnace
Its burner works much like a car engine—and it doesn't need a chimney. PAGE 97

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Create new storage space, re-side and insulate at the same time, more. PAGE 101

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Sears Fall Fix-up Festival

NOW SAVE 10% TO 50% ON SELECTED MERCHANDISE:

FIX-UP TOOLS ■ INSTALLED HOME IMPROVEMENTS ■ PAINT & PAINT SUPPLIES ■ BATH & KITCHEN IMPROVEMENTS ■ DO-IT-YOURSELF SUPPLIES ■ ENERGY EFFICIENT PRODUCTS ■ HOME SECURITY ITEMS

AND TAKE ADVANTAGE OF THESE NATIONWIDE EXTRAS

- Expert planning help
- Authorized installation available, ask for the installed price
- One-year installation warranty*
- Wide range of do-it-yourself guides
- Prompt delivery service
- Wide choice of models, styles and prices
- Famous quality names like Craftsman,® Kenmore® and Weatherbeater®
- Most replacement parts available for ten years after purchase
- Free estimates
- Credit plan to suit most any need
- Wide range of maintenance agreements

Satisfaction Guaranteed or Your Money Back

You can count on

Sears

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*Should the workmanship of Sears arranged installation prove faulty within one year, Sears will correct it at no additional cost.

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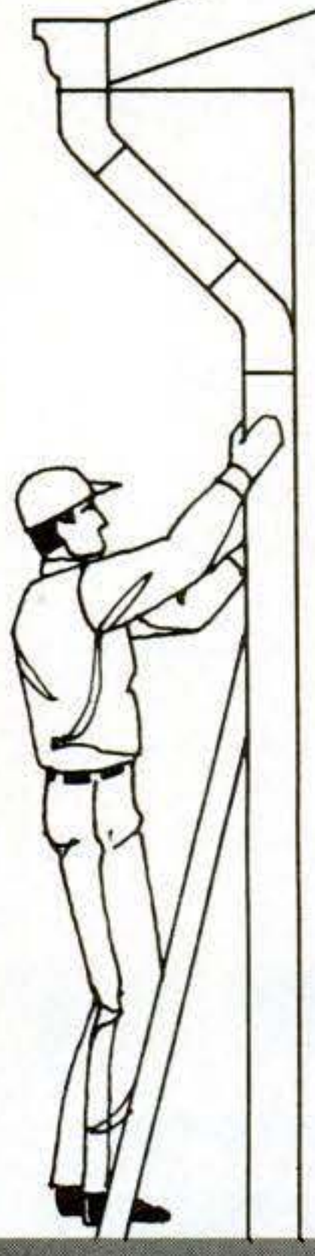
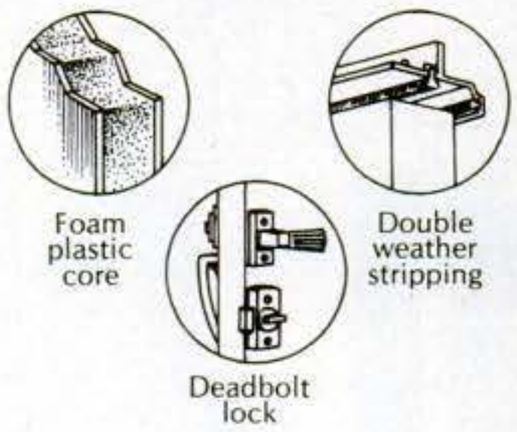
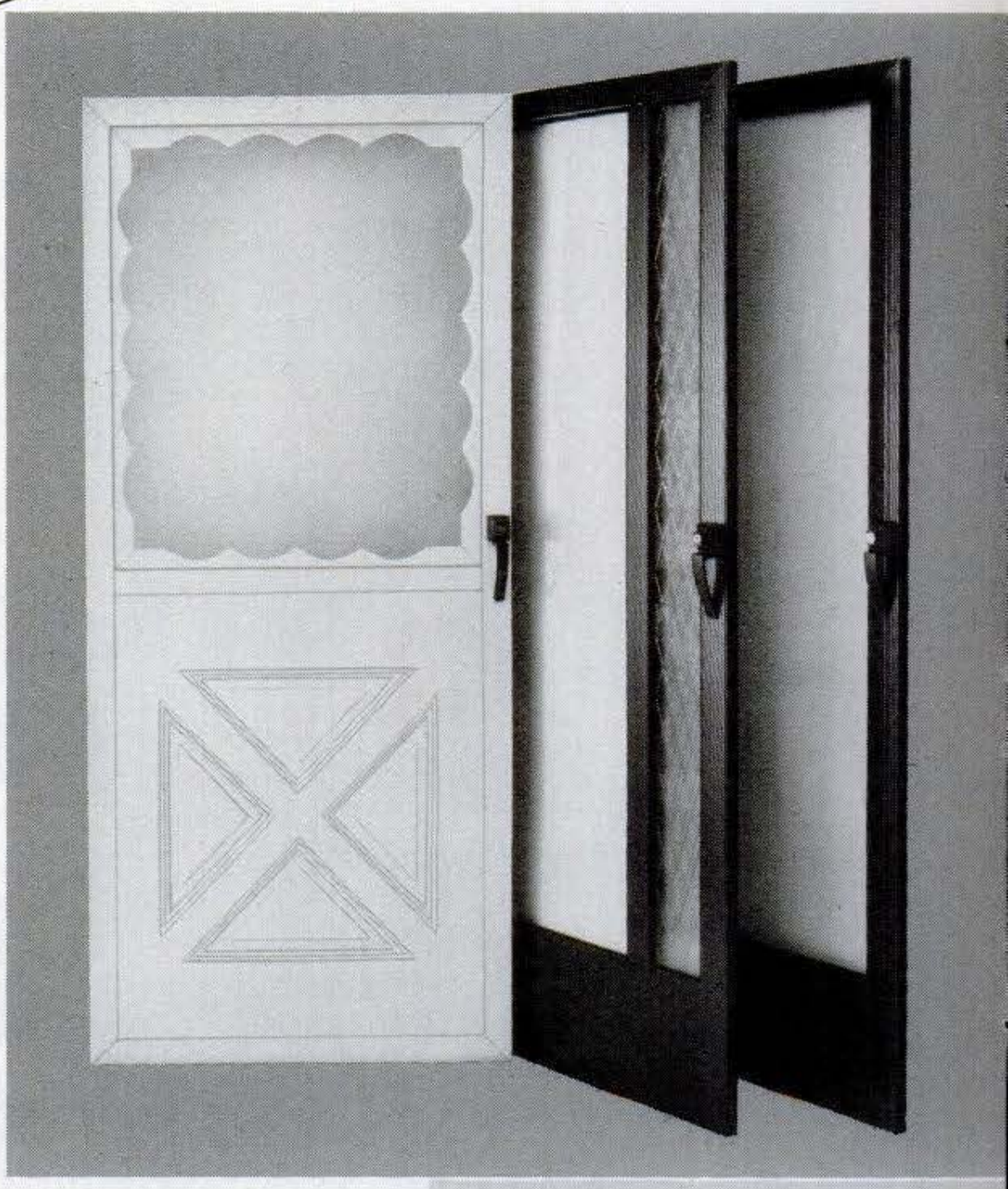
SUPER FIX-UP VALUES FOR THE OUTSIDE OF YOUR HOME

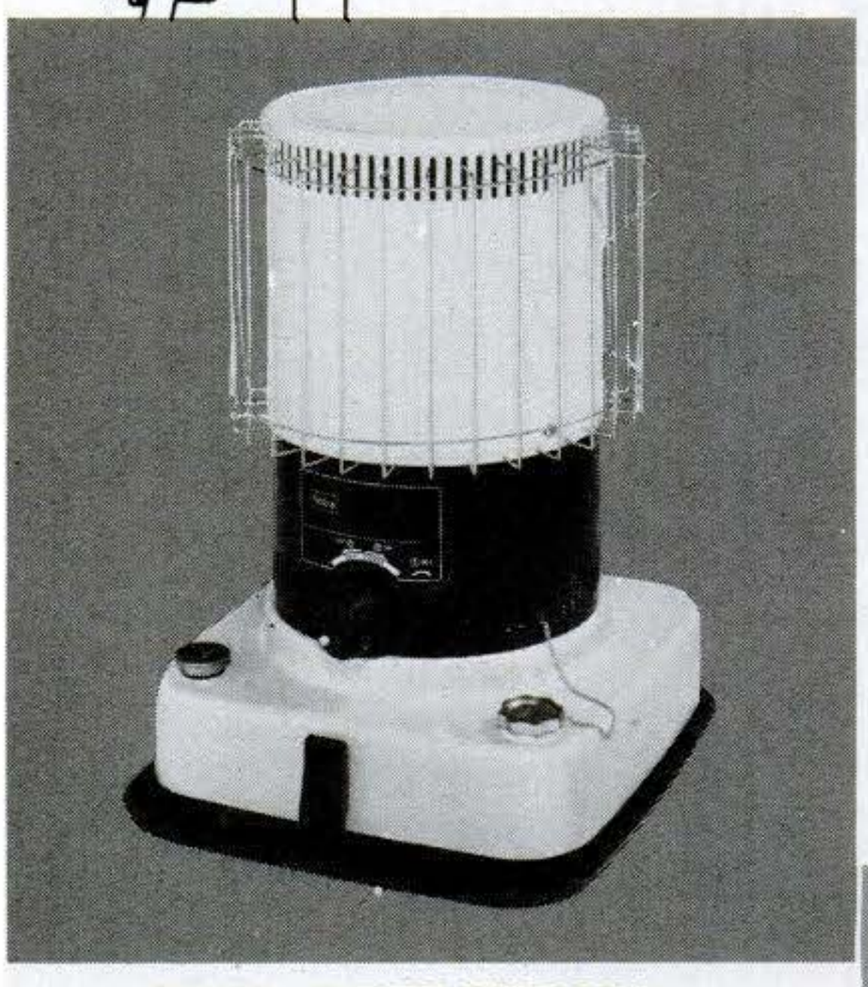


SAVE $40
Insulating Storm/Screen Door
$159.99*



Sears premium storm door offers attractive styling along with features that provide durability, security and insulation. Includes 1¼-in. thick aluminum frame filled with foam-plastic core; massive keylock latch and deadbolt. In sizes, 32-in. x 80-in. and 36-in. x 80-in. Choice of styles: Crossbuck (#2327), Full-view (#2328) or Side-lite (#2331).
ON SALE: Aug. 29-Sept. 25.



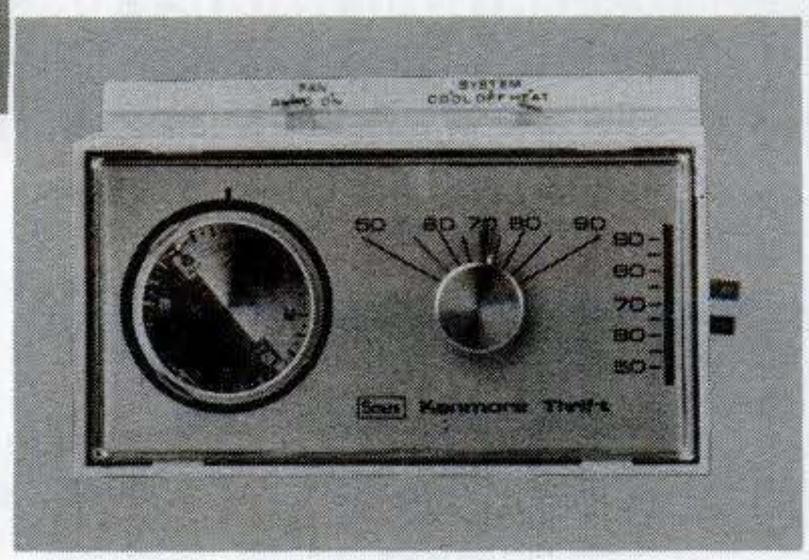


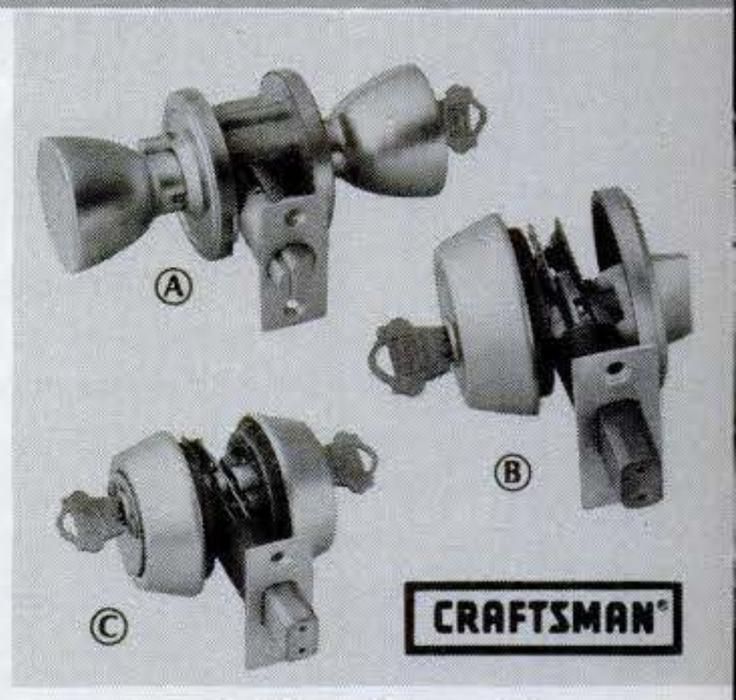
SPECIAL PURCHASE†
Kenmore® Thrif-T Thermostat with Triple Set-back
$39.99*

Set it for day and for night. Can save you 6% to 30% on heating and/or cooling costs. For 24-volt gas, oil or electric furnaces. (#9100)
AVAILABLE: Aug. 29 (while quantities last).

SAVE $100
Sears Convection Wick Heater
$199.99

Portable, yet produces 20,000 Btuh. Puts heat where you want it. Uses cost-efficient kerosene. 1.6 gallon capacity. Push-button start; tip-over safety off-switch; UL listed. (#40311) Note: Some locations restrict sale or use. Check your local codes. California law prohibits sale for use, or use of such unvented heaters, in dwellings.
ON SALE: Aug. 29 (close-out...while quantities last).





SAVE $3 to $5
ENTRY LOCK SET AND DEADBOLT LOCKS

Ⓐ **Entry Lock Set. Now $8.99.** Anti-shim deadlatch helps prevent bolt from being opened. In bright brass finish. Need only a screwdriver to replace worn lock sets. (#57401 or #56661) Save $3.00.
Deadbolt Locks. Two steel inserts in bolt resist sawing by rolling with blade. 1-in. throw makes it tough to pry door open. In bright brass finish.
Ⓑ **Single Cylinder Deadbolt. Now $14.99.** (#57425 or #56671) Save $4.00.
Ⓒ **Double Cylinder Deadbolt. Now $16.99.** (#57427 or #56674) Save $5.00.
ON SALE: Aug. 29-Sept. 11.

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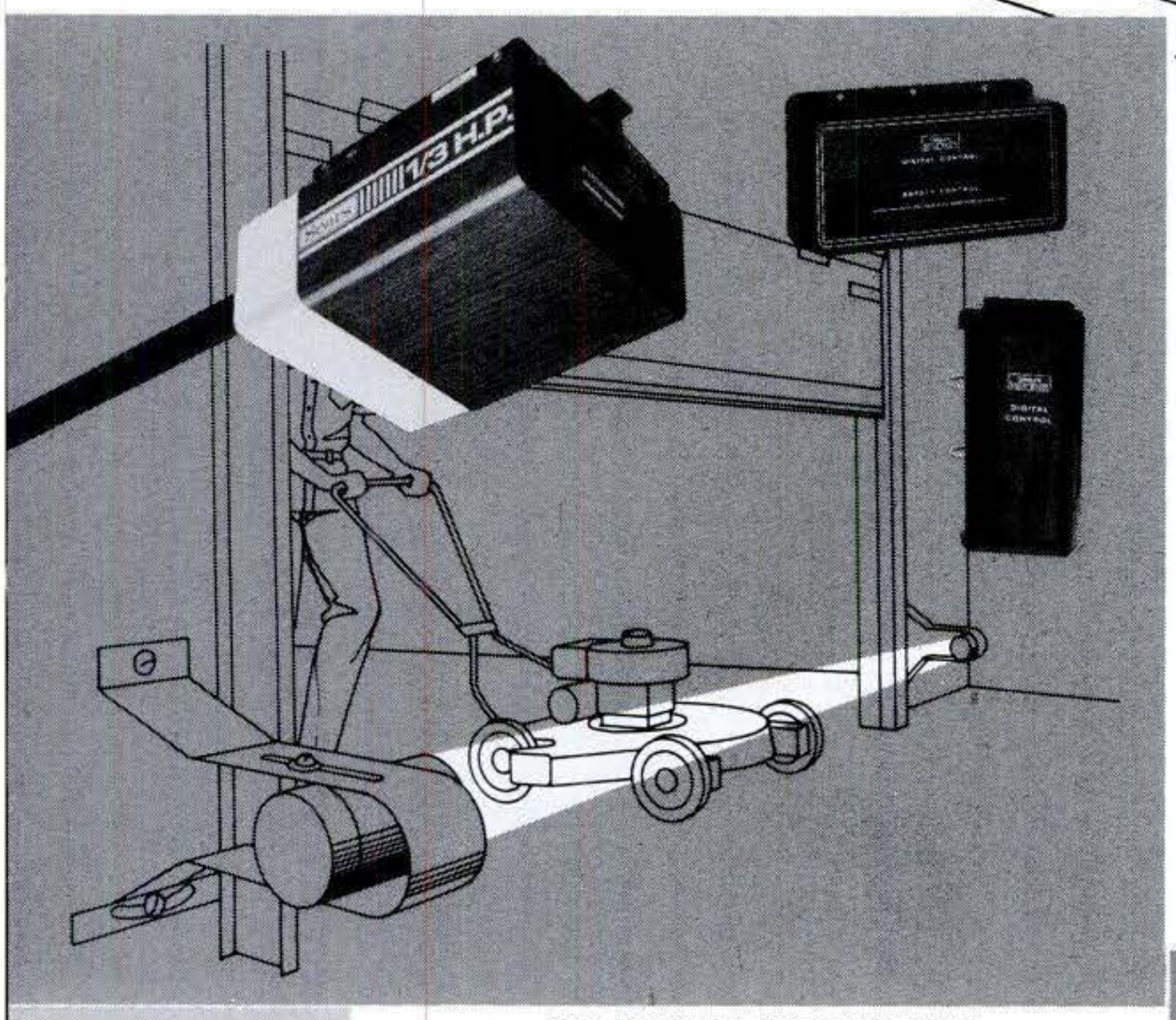
Sears Fall Fix-up Festival



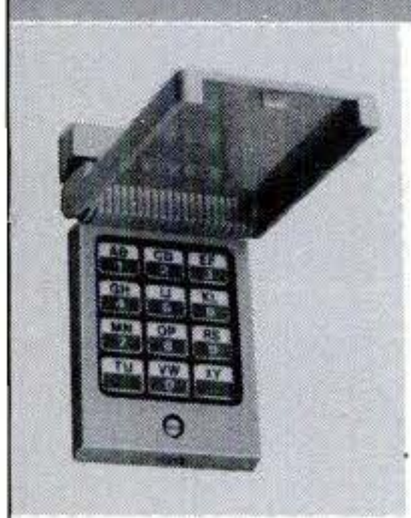
Ⓐ **SAVE $1.00** on Sears Best Draft Barrier™ Weatherstrip Tape. Adhesive backed vinyl; 1-in. x 17-ft. (#74847) . . . . . Now **$1.99***

Ⓑ **SAVE $2.00** on Plastic Sheeting. 4-mil. thickness; 250 sq. ft. (#74856) . . . . . Now **$4.99***

Ⓒ **SAVE 50¢** on Outlet Sealers. Includes 7 outlet seals, 3 switch seals. (#74838) . . Now **99¢**

Ⓓ **SAVE $1.50** on Aluminum Thresholds.
36-in. x ¾-in. (#74881) . . . . . Now **$3.49***
36-in. x 1 1/16-in. (#74882) . . . . . Now **$4.49***
Ⓐ-Ⓓ ON SALE: Aug. 29-Sept. 11.

Ⓔ **SAVE $1.35** on Sears Acrylic Latex Caulk. Fast drying and flexible. (#38101) . . . . . Now **$1.34**
ON SALE: Aug. 22-Sept. 11.

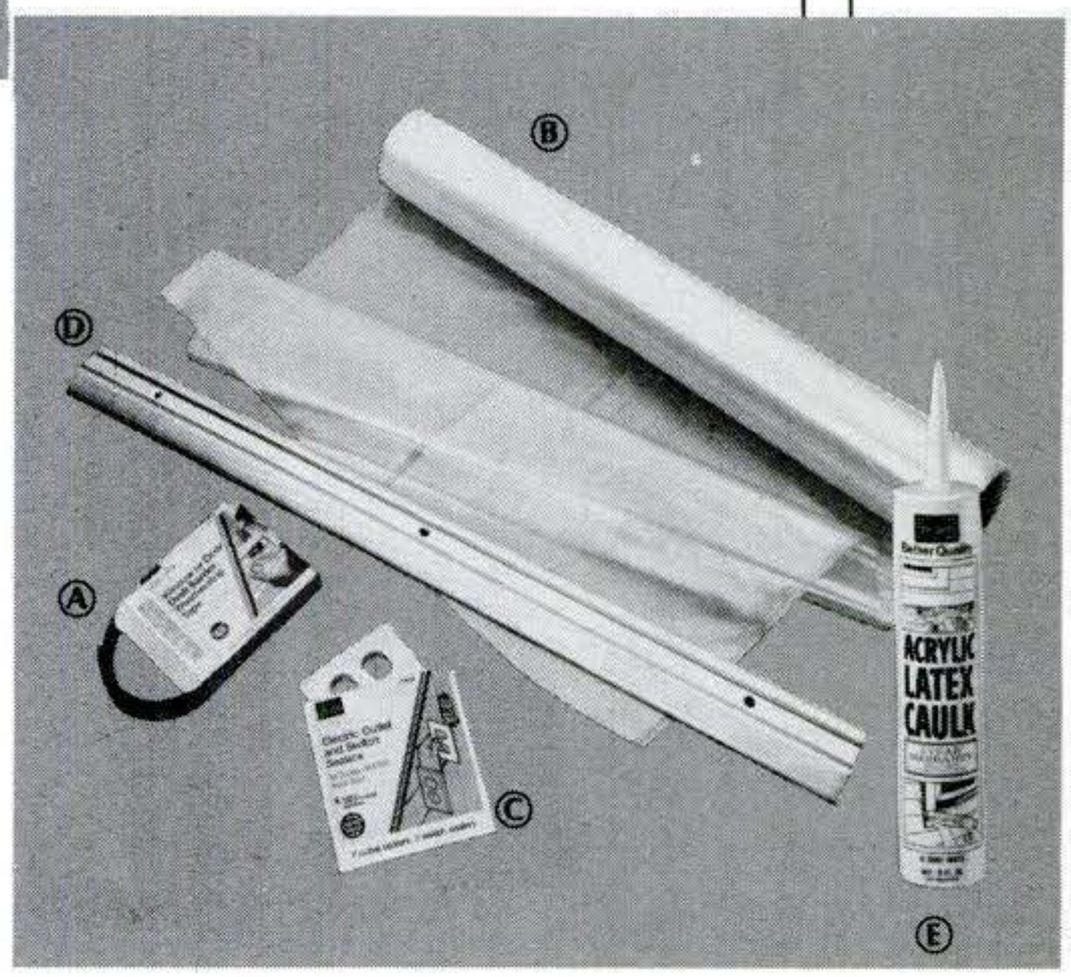


SPECIAL PURCHASE†
Sears Garage Door Opener with Reversing Sensor

$169.88

Safety and security designed. If invisible beam is broken, closing garage door automatically reverses itself before it touches anything. ⅓-HP motor; 4½-min. light delay; over 19,000 digital codes. Includes transmitter. (#6555)
AVAILABLE: Aug. 29 (while quantities last).

Sears Digital Touch Code Lock. Now $39.99. Opens automatic garage door without using transmitter. No need to carry house keys if you have an attached garage. Works with Sears and most other automatic garage door openers. (#6527) **Save $10.**
ON SALE: Aug. 29-Sept. 25.



SAVE 50%
on Armadillo® Chain Link Fence fabric when you buy posts, top rail and fittings at Sears regular low prices.
11½-gauge galvanized steel chain link fence fabric. 36, 42, 48, 60 and 72-in. heights available. (#9002)
ON SALE: Aug. 29-Sept. 18.

SAVE 10% TO 20% ON THESE INSTALLED IMPROVEMENTS

• **BLOWN-IN INSULATION.*** Helps reduce your heating and cooling costs. **Save 10%** on the installed price. ON SALE: Aug. 29-Sept. 11.

• **CONTINUOUS ALUMINUM GUTTERING.** We'll go to any length for you. Guttering is custom-fitted to your home. In choice of colors. **Save 10%** on the installed price.
ON SALE: Aug. 29-Sept. 11.

• **GLASS FIBER ROOFING SHINGLES.** Have 75% more weatherproofing asphalt than comparable weight felt-based shingles. Highest fire resistance rating (Class A) from UL. **Save 20%** on shingles when Sears arranges installation. (#34721)
ON SALE: Aug. 29-Sept. 18.

***Price of this merchandise can be used toward computing energy tax credit.**

†A special purchase, though not reduced, is an exceptional value.
Minimum savings nationally.
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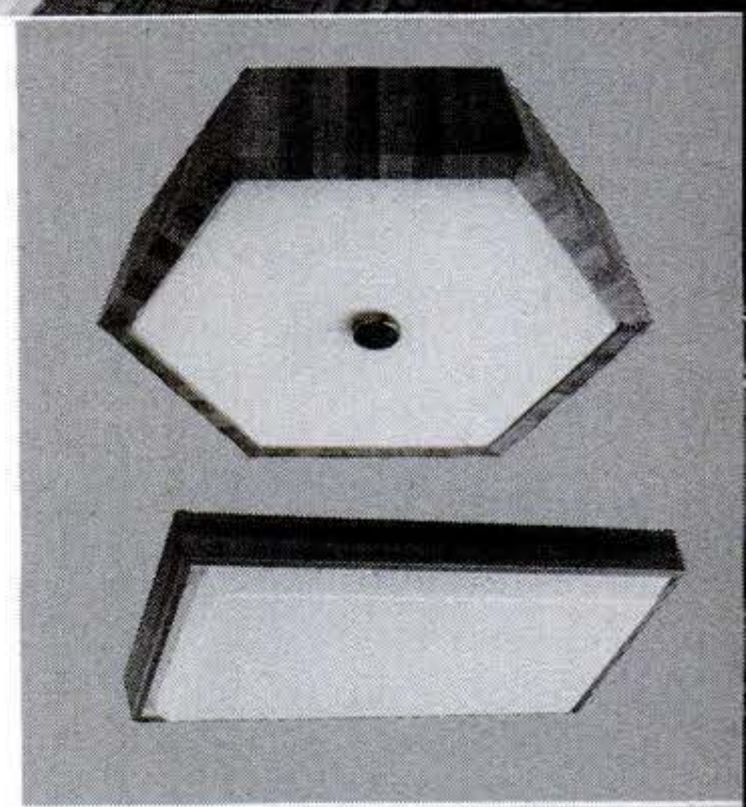
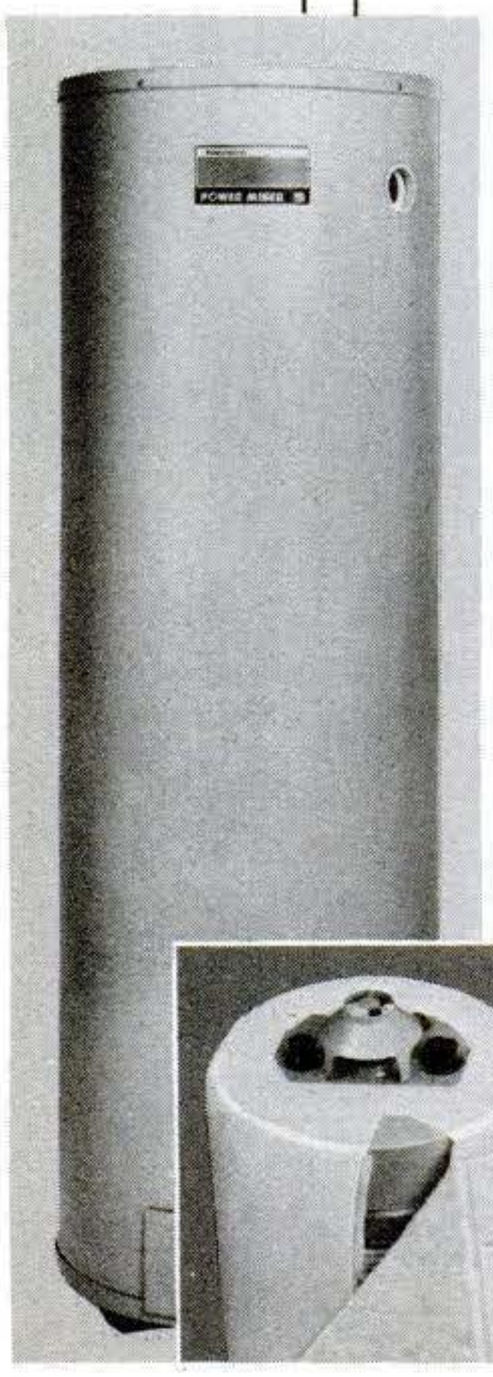
SUPER FIX-UP VALUES FOR THE INSIDE OF YOUR HOME

SAVE 1/3 to 1/2
Sears Kitchen Cabinets

So many ways to see your dream kitchen come true. A wide choice of looks, of woods, of sizes to match your taste and budget. Our Brookside Oak (#6400 Series) with solid oak doors, front frames and drawers is shown above, but there are 10 other beautiful styles to choose from. And all at wonderful savings. ON SALE: Aug. 29-Sept. 18.

Does not include sinks, faucets, countertops, or appliances. Professional installation available.



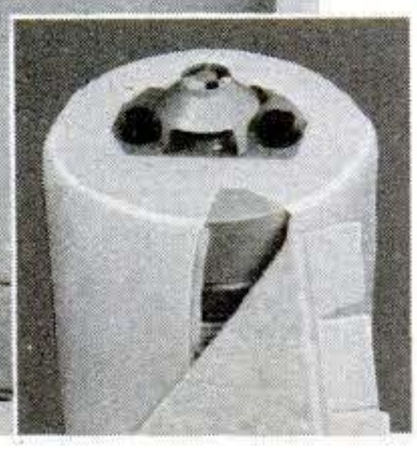


SAVE $20
Kenmore® Power Miser™ 5 Water Heater
$149.99

Energy-efficient foam insulation helps save money, helps prevent heat loss. Provides up to 175% greater insulating effectiveness than our standard models. 24-hour emergency installation available weekdays. Installation extra. Or install it yourself. 30-gal. Gas (#33434) or 40-gal. Electric (#31444).
ON SALE: Aug. 29-Sept. 18.

SAVE $10 or $15
Butcher Block-look Light Fixtures

Fashionable wood look complements any decor. Energy-saving fluorescent bulbs use 59% to 67% less energy than incandescents, while providing equal light output.
Hexagonal. Now $49.99. Includes one 22 and one 32-watt warm white circline bulbs. (#9139) Save $15.
Rectangular. Now $29.99. Includes two 20-watt warm white bulbs. (#9198) Save $10.
ON SALE: Aug. 29-Sept. 11.



SAVE $5
Water Heater Insulation Jackets

Wrap your present water heater with this high-density insulation jacket. Helps cut energy costs. R value = 6.0.
For electric heaters. Now $12.99.* (#1722)
For gas heaters. Now $9.99.* (#1723)
ON SALE: Aug. 29-Sept. 11.

SAVE $10
Kenmore® Disposer
$69.99

Powerful ½-HP motor. Corrosion-resistant stainless steel grinding chamber and ring. Quick-mount collar for easy do-it-yourself installation. (#6653) ON SALE: Aug. 29-Sept. 18.

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Sears Fall Fix-up Festival

SAVE $6 and $7
Easy Living® and Weatherbeater® Paints

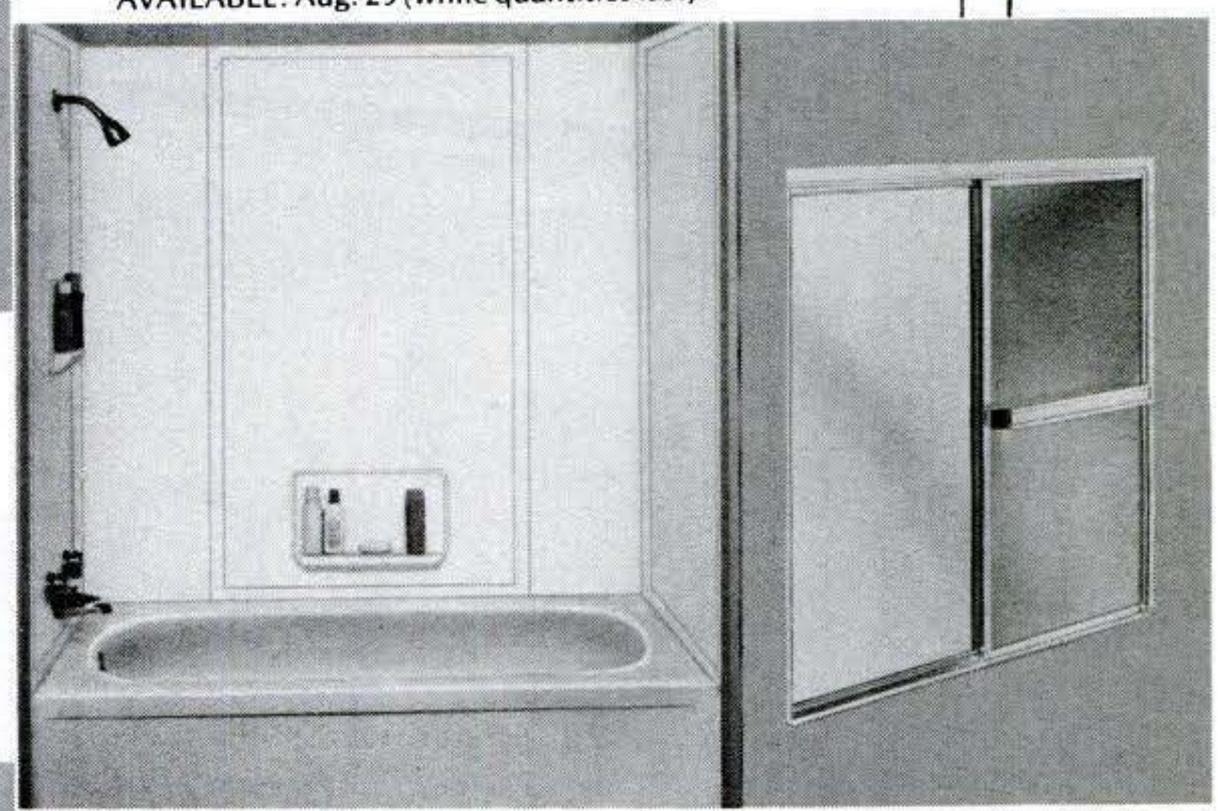
$9.99
per gallon

Sears Best paints give you smooth one-coat coverage when applied as directed. Easy Living Interior Satin Flat (#91005) wipes clean like enamel, comes in 23 colors. Weatherbeater Exterior Flat (#30005), its name is its promise. Same low price, too, for Easy Living Ceiling Paint. (#91955)
Easy Living Interior Semi-Gloss. Now $11.99 per gal. (#78005) Save $5.
ON SALE: Aug. 22-Sept. 11.

SPECIAL PURCHASE†
Washerless, Single-Control Faucets

$22.88

Bright, triple-chrome plating. Includes water-saving aerator.
Lavatory Faucet. (#20612)
Kitchen Faucet. (#21922)
Kitchen Faucet with Sprayer. Only $29.88. (#21932)
AVAILABLE: Aug. 29 (while quantities last).



SAVE $20
Tub Wall Surround

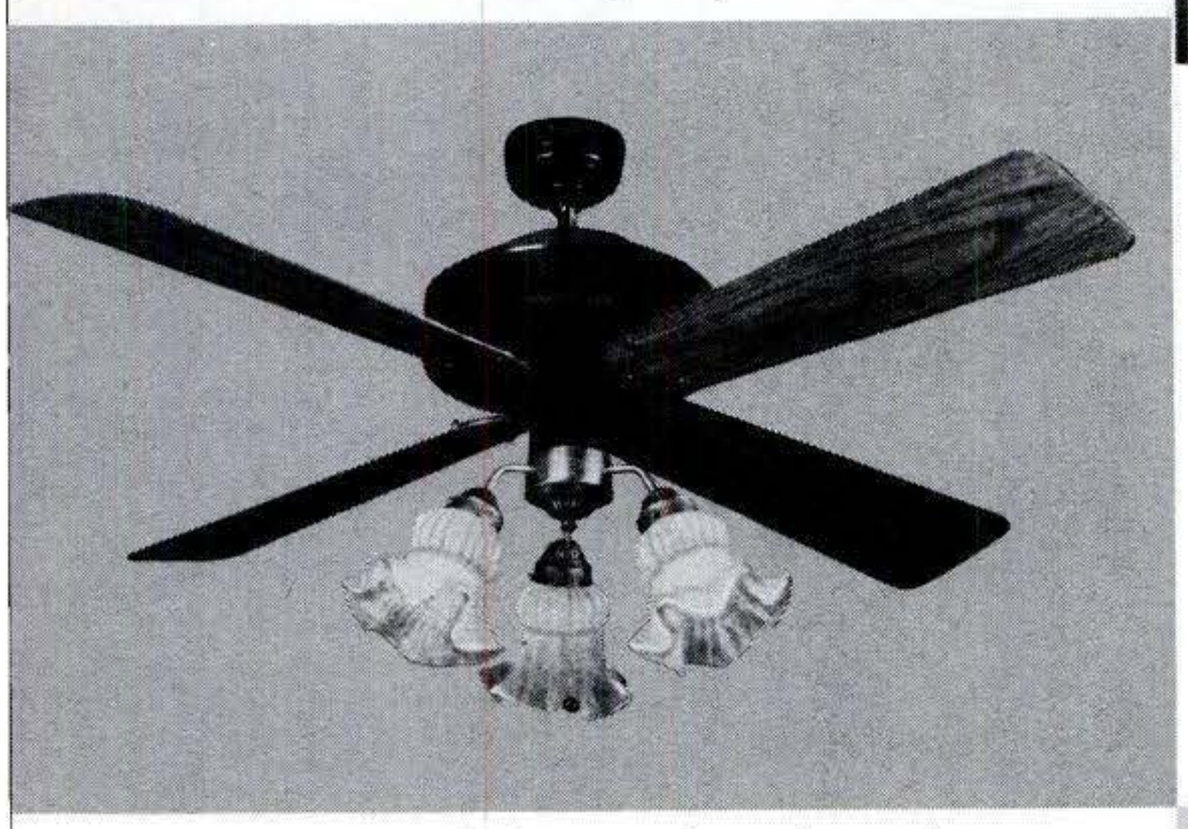
$79.99

5-pc. construction for easy adjustment to fit most 5-ft. tubs. Two soap/storage shelves. Fashionable textured finish. In White. (#6761)
In Blue, Gold or Bone color. Now $89.99. (#6762, #6763, #6764) Save $20.
ON SALE: Aug. 29-Sept. 11.

SAVE $40
Mirrored Tub Door

$99.99

Designed for easy installation. Bottom track won't trap soap scum; so it's easy to keep clean. Choose frame in Silver tone (#68075) or Gold tone (#68076).
ON SALE: Aug. 29-Sept. 11.



SAVE $50
52-in., 3-Speed Ceiling Fan

$99.99

Adds beauty and nostalgia, and it's energy efficient. Uses only 10 watts of power on low speed. Helps circulate room air for summer cooling and winter heating. Your choice in either Brown or White with woodgrain polystyrene blades to match. (#9042, #9044)
ON SALE: Aug. 29-Sept. 25.
Decorative Victorian 3-light fixture. Sears everyday low price, $39.99. (#93001)

SAVE $1
Smoke Alarm

$9.79

Solid-state circuitry with test button. Includes 9-volt battery. UL listed. (#57351)
ON SALE: Aug. 29-Sept. 25.

SAVE $100
Kenmore® High-Capacity Water Softener

$379.99

It will help your glasses and dishes sparkle. You'll feel cleaner after bathing or shampooing. Removes up to 50 grains of hardness per gallon of water. (#3483)
ON SALE: Aug. 29-Sept. 18.

•Price of this merchandise can be used toward computing energy tax credit.
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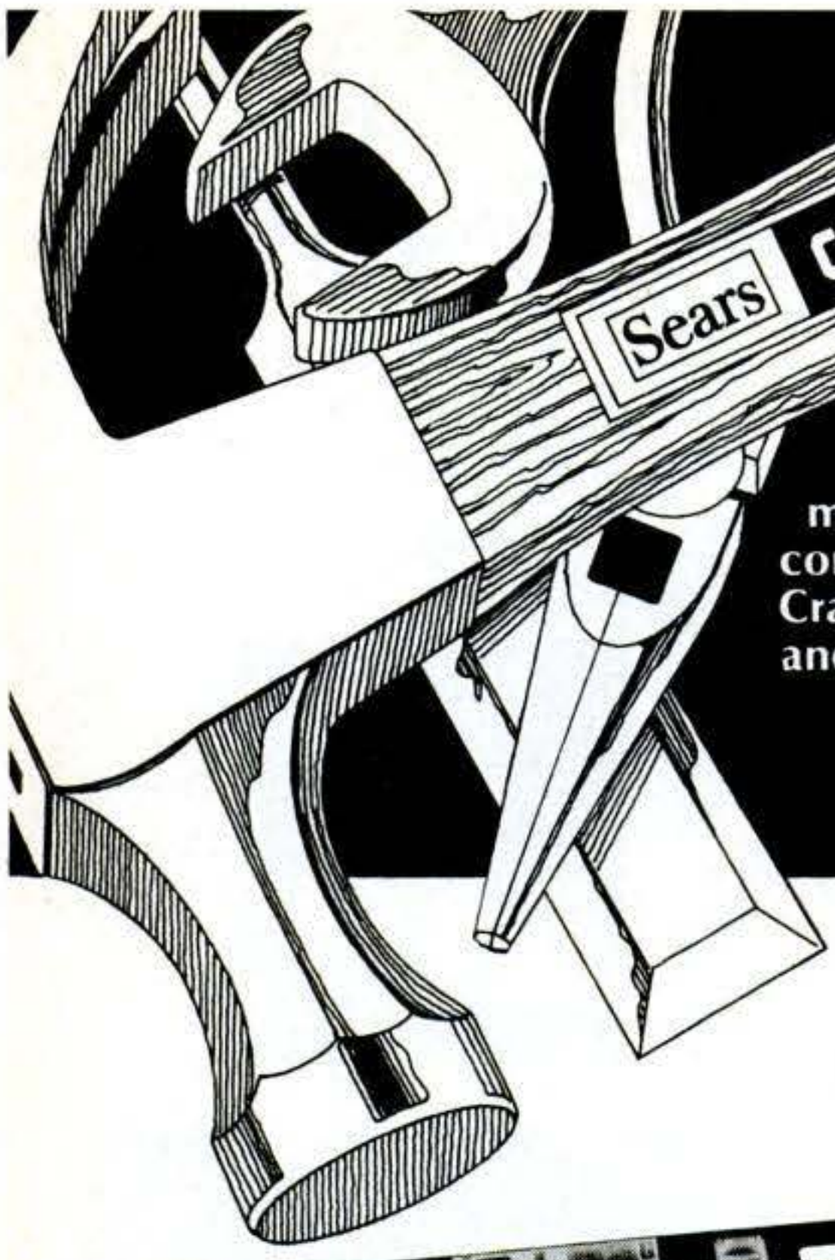
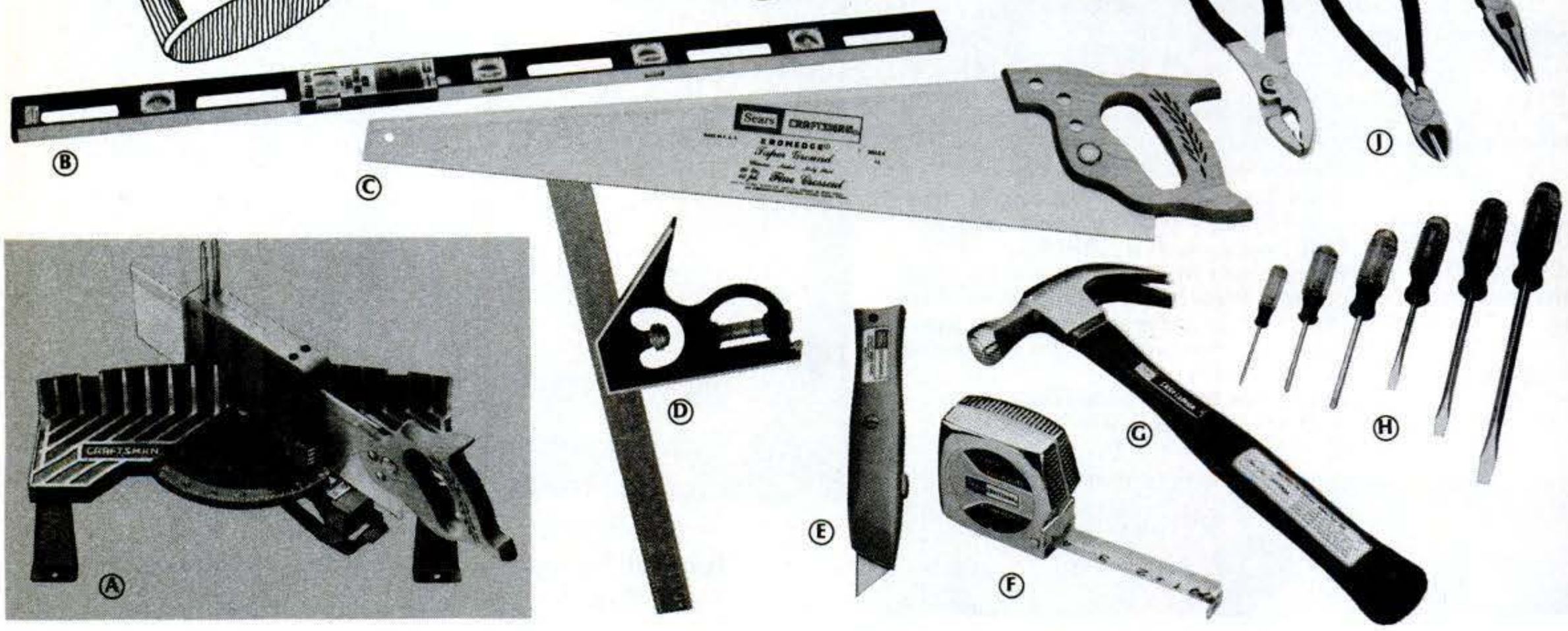


PROFESSIONALS AND DO-IT-YOURSELFERS BUY MILLIONS OF CRAFTSMAN® TOOLS EVERY YEAR. HERE'S WHY:

■ Full unlimited warranty on all Craftsman hand tools† ■ America's most complete brand line of power and hand tools ■ America's most complete brand line of accessories ■ Sears high quality standards; every Craftsman tool must earn its name ■ A wide selection of models, styles and prices ■ 55 years of providing quality engineering and workmanship

SAVE 29% TO 63%

BRAND Craftsman Fall Fix-up Values



Ⓐ **SAVE $20** on Miter Box and Saw Outfit. Comes complete with 16-in. Kromedge® back saw. Four treaded rollers guide the saw. (#36304) **Now $39.99.**

Ⓑ **SAVE $10** on 48-in. Level. (#39936) **Now $19.99.**

Ⓒ **SAVE $5** on Handsaw. 8-pt. saw (#36153) or 10-pt. saw. (#36154) **Now $11.99.**

Ⓓ **SAVE $4** on Combination Square. (#39558) **Now $7.99.**

Ⓔ **SAVE $1.50** on Utility Knife with blades. (#9487) **Now $1.99.**

Ⓕ **SAVE $4** on 1-in. x 20-ft. Tape. (#39131) **Now $8.99.**

Ⓖ **SAVE $5** on Hammer with Steel-Reinforced Wood Handle. (#38141) **Now $8.99.**

Ⓐ-Ⓖ ON SALE: August 29-September 18.

Ⓗ **SAVE $12.05**** on 6-pc. Screwdriver Set. (#41091) **Now $9.99.**
ON SALE: Aug. 29 (while quantities last).

Ⓘ **SAVE $16.98**** on 3-pc. Plier Set. (#45285) **Now $9.99.**
ON SALE: Aug. 29 (while quantities last).

7¼-in. Circular Saw
HALF PRICE*
Now $39.99

Powerful 2-HP motor delivers 4600 rpm. Depth and bevel controls; ball and bronze bearings. (#1080)
ON SALE: Aug. 29 (while quantities last).

SAVE $200
Sears Best 1-HP Compressor
$399.99

Delivers 7.5 SCFM at 40 PSI. 12-gal. ASME tank. Includes spray gun, air hose and tire chuck. (#15821)

SAVE $160
Sears Best 10-in. Cast Iron Table Saw Outfit
$329.99

Comes with rugged leg set and two steel extensions. 1-HP motor develops 2-HP. Has 3⅜-in. depth of cut at 90°, rips to 24-in. (#29803)

†If any Craftsman hand tool ever fails to give complete satisfaction, return it for free replacement.
*Savings based on 1982 Fall General Catalog prices.
**Savings based on regular separate retail prices. Minimum savings nationally.
Prices and dates apply only to the continental United States. Available at most Sears retail stores.

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PS READERS TALK BACK

Address letters for this column to: Readers Talk Back, Popular Science, 380 Madison Ave., New York, N.Y. 10017. Because of the large volume of mail, we are unable to acknowledge unpublished letters.

Decade of discovery

Which came first, the motor or the generator? My reference book gives the generator first position with Michael Faraday's invention in 1831. It could be classified as a homopole generator. Your fine article "Electromagnetic Launchers" [PS, Nov. '81] states that in 1821 Peter Barlow invented a homopole motor. My money is on Faraday. I think your 1821 date is a little off.

Robert L. David, Las Vegas, Nev.

Daniel Ruby replies: "Although it was based on Barlow's 1823 experiment (1821 was wrong), Faraday's rotating-disc apparatus gets credit as the first generator because it came within the context of his other experiments in electricity and magnetism and, thus, was explained for the first time. The first practical electric motor (another rotating wheel, built in 1834) is attributed to the American Thomas Davenport."

Beauty or a beast?

Halogen bulbs in the home [PS, July]? No way. I work with the little beasts at a local TV studio and would discourage their use in the home for the following reasons: (1) They run hot—up to 500 degrees F. Nothing that generates that kind of temperature should be used in a living room, save the family fireplace. (2) They are unreliable. Their life span can vary over 50 percent from what is predicted (usually on the minus side). One touch from an ungloved hand shortens this even more. (3) *They can explode.* I've seen even the low-wattage ones self-destruct. I am certainly for new and unique forms of lighting, but halogen is not the way to go.

Jeffrey D. Sterling, Franklin, Pa.

Solar vs. heat pumps

I feel that you didn't give solar hot-water systems their due in your "Heat-Pump Water Heaters" article [PS, May]. My SolarSense system has been operating for a year and four months now. In that time, my 4.5-kWh electric backup heaters have run only 61.4 hours. At 10 cents per kilowatt-hour, that's just $27.63. Running the controls and pump has cost about $54 more. My old system, a tankless heater on an oil burner, used about 300 gallons of oil a year for hot water alone. With oil at $1.20 a gallon, that would be $360 a year for hot water. After federal and state tax credits, the installed price of my system was $1,609.

The major problem with solar is that there are far too many people selling systems, and many have little if any knowledge of what they are doing. Before buying, shoppers should investigate to see that the vendor has the expertise necessary to install a system properly and to back up that installation with instant and effective service.

Jim A. Hancock
West Falmouth, Mass.

Evan Powell replies: "The numbers in the solar comparison were not mine, but from the Solar Energy Research Institute, and the conclusion favoring heat-pump water heaters is that of a DOE report based on a study at Oak Ridge National Laboratory. I couldn't agree more with your observation about the importance of proper solar installation [see "Solar Home Secrets," PS, Aug.]. Unfortunately, the excellent performance you're getting from your solar system is all too rare."

Micro-mini mania

Having recently purchased a Nissan Stanza XE, I thought it was state of the art for combining roominess, economy, and zip. Then, in February, my wife and I had an opportunity to ride in a Daihatsu Charade ["Micro-Minis," PS, June] while visiting our exchange-student daughter in Chile. I am over six feet tall, but I found her car plenty roomy. Its 843-cc engine had ample zip for running around town (and, believe me, you need extra zip for crossing

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PS readers talk back

[Continued]

intersections in Valparaiso, Chile). And though lacking trunk space, it has most of the amenities our Stanza has. Our daughter reports that her Charade averages 15 kilometers per liter around town, about 36 mpg. I think Daihatsu is missing a bet by not exporting them to the U.S. They'd sell like hotcakes.

William J. Wilson, Boise, Ida.

What a shame that Honda has no plans to bring its City car into this country. It's exactly what I need.

Octavia H. Ryerson, Winter Park, Fla.

So what's new? I have been driving a Fiat 850-cc RDSTR and Coupe since 1968. With all the new micro-minis, other drivers will be joining me. OPEC has finally brought us to our senses. Why do we need two tons of iron to take us to the supermarket?

Art Vermeers, La Crescenta, Calif.

If the American auto companies swing deals with foreign affiliates to bring the micro-minis here, as the article implies, then their "buy American" sales pitch isn't going to wash anymore. Don't they know there's an employment crisis going on? Within five miles of where I'm writing this letter there is a big empty automobile assembly plant.

Irving Deutsch, Monsey, N.Y.

Muscle cars

In your "Muscle Cars" test [PS, June], the Mustang GT is listed as accelerating from zero to 60 mph in 9.7 seconds. *Motor Trend* went zero to 60 in 7.78 seconds—a two-second difference. If you guys can't do any better than that, you should stay out of these cars and leave muscle-car testing to the high-performance magazines.

Scott Martin, Federal Way, Wash.

How come the shabby performance of the Trans Am's brakes (188-foot hot-brake stopping distance) is found only in the fine print of the tabulated test results? Stopping performance is important in all cars, but especially so in a car that's meant to be driven fast.

Raymond W. Waugh, Sunnyvale, Calif.

What were Jim Dunne's criteria for his choice of the GM cars over the Mustang? The latter accelerated faster, stopped quicker, got much better fuel economy, and cost $1,350 and $1,791 less than the respective Firebird and Camaro. I rest my case.

David Owen, Westboro, Mass.

Jim Dunne replies: "We do our acceleration tests with two people and 50 pounds of test equipment aboard, then we average the results from a number of two-way runs (otherwise the road gradient, winds, etc., would influence the result). Another reason for the discrepancy may be tires: Bigger, fatter tires take more of the power of the engine than skinny ones. That means less wheel spin and faster times.

"We recognize the importance of

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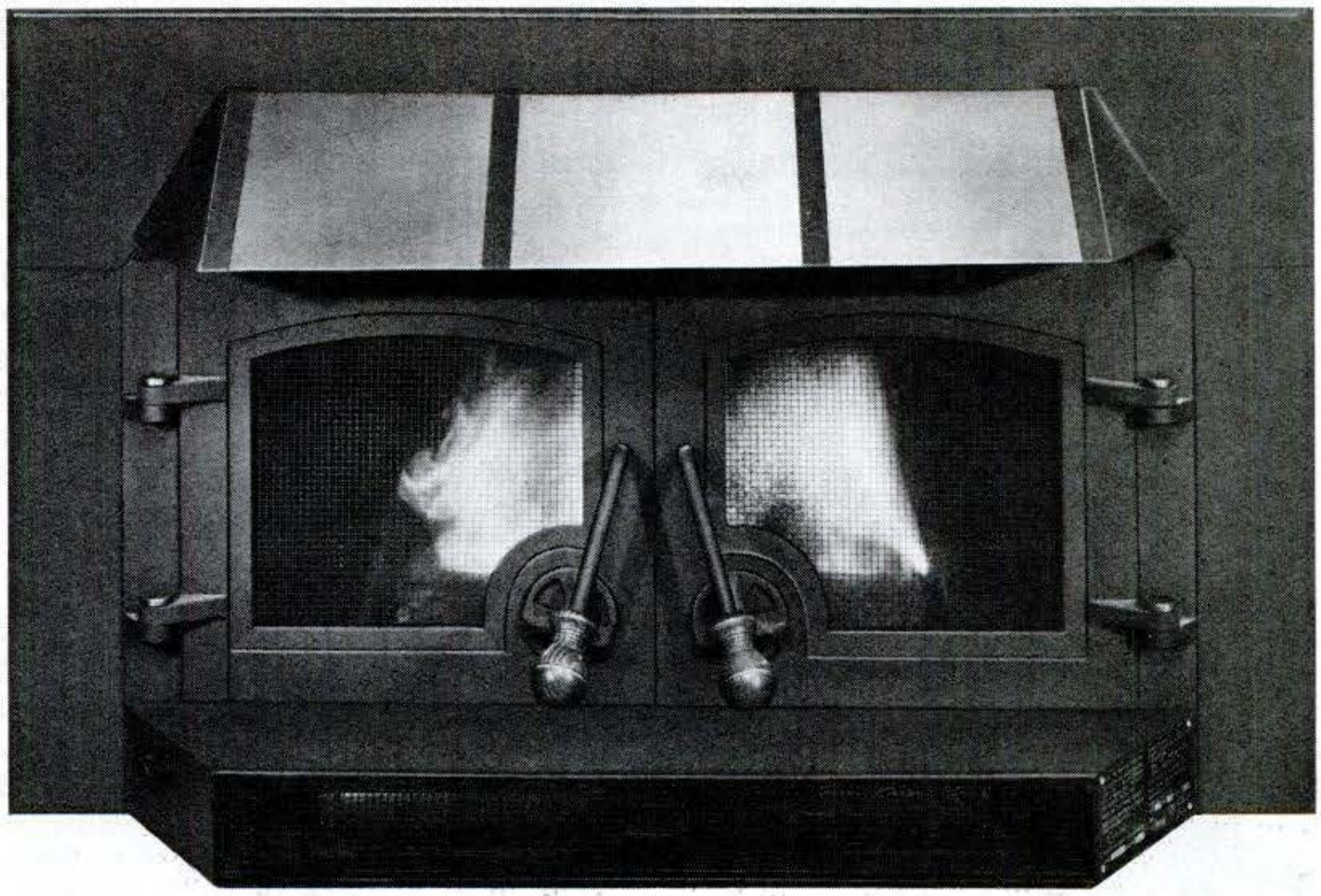

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No matter how much pleasure it may give you, your ordinary fireplace squanders heat—and money.

It steals some 90% of the heat from the wood you burn and sends it up the chimney.

It contributes to the drain of warm air from your home (up to 10,000 BTU's of heat an hour for every room you use) and replaces this warm air with cold air sucked in from under doors and windows.

Worst of all, your fireplace can dramatically inflate your fuel bill by forcing your central heating system to work overtime.

Fortunately, you can now stop this costly heat-loss chain reaction. With an Ironwood Fireplace-Stove.™

Give your home up to 50,000 BTU's of extra heat an hour—right from your fireplace.

Three times more efficient than most fireplaces, an Ironwood Fireplace-Stove yields as much heat as many small home furnaces—*on less than half the wood an ordinary fireplace consumes.*

Because an Ironwood is airtight, it uses 92.5% less air than your fireplace. So your fire burns at a slower and better rate of combustion. And, cold air doesn't surge inside your home to feed the updraft.

Turn off your thermostat and enjoy your fireplace while you reduce your heating bill.

An Ironwood Fireplace-Stove circulates more than 100 cu. ft. of constant warmth throughout one room or your whole house. It's the perfect way to heat a bedroom, family room, den or living room, whenever you want. On a fraction of the wood you'd normally burn.

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Made and warranted by CWC Textron, one of the oldest and best known cast iron foundries in America, the Ironwood Fireplace-Stove is an airtight unit that fits handsomely and easily in most masonry fireplaces.

You'll enjoy watching a fire through its shatter-resistant safety glass doors of Pyroceram® by Corning!

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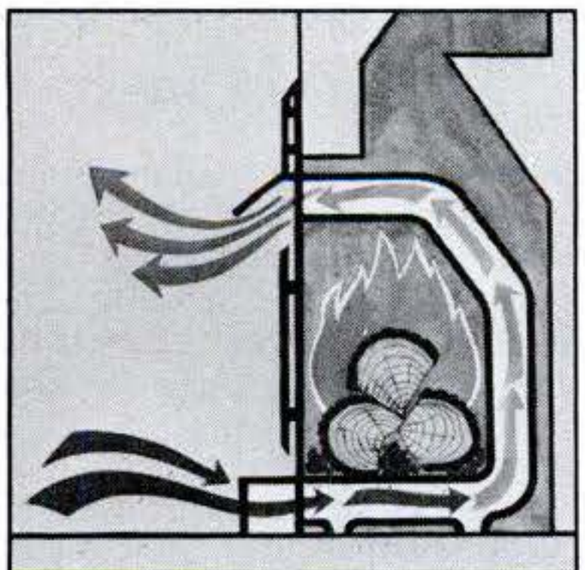
Last but not least, the Ironwood has passed stringent Underwriter's Laboratories Tests and carries the UL Listing.

Year-in and year-out, you can rely on efficient and economical Ironwood fireplace heat.



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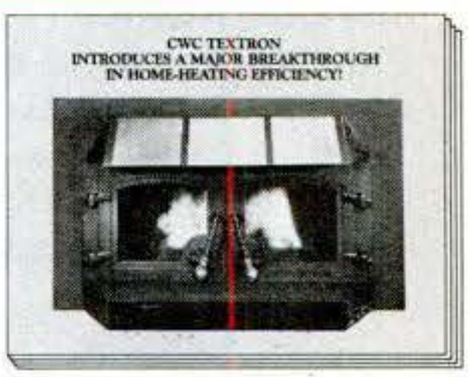

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PS readers talk back

[*Continued*]

brakes and grade cars accordingly in the 'nutshell' box. But because of the difficulty of relating stopping distances to the reader's experience, we rarely mention brakes in the text of the article unless we consider them to be dangerous.

"As for the disputed pick, that's the luxury of a subjective choice: One doesn't have to justify it with numbers. I found the GM cars unquestionably more pleasant to drive."

Windy chimney

I have installed a roof ventilator turbine ["Summer Cooling," PS, April] with great success—but not for cooling my attic. For years I've been plagued with erratic breezes that blow down and around the steep hillside behind my house and into my fireplace chimney. No shroud or cover seemed to help—those I made were either ineffective or restricted the draft—until I hit on the idea of using the turbine. I reasoned that since these turbines are designed to exhaust air when a wind is blowing, one should at least prevent air from going down the chimney in similar circumstances.

I bought a turbine with a two-ft.-dia. neck and secured it atop the chimney liner with angle brackets and lag screws into the concrete. I also routed a cooling duct of two-inch vent pipe through the unit's mounting flange to protect the turbine's bearings from heat. This setup has completely solved my wind problem. Draft restriction, if any, is minimal.

Kennan C. Herrick, Oakland, Calif.

Stainless steel

My husband and I have owned a De Lorean since October and drove it daily through the Michigan winter. At first we did experience a staining problem ["Detroit Report," PS, June], but later found that Amway Metal Cleaner, used exactly as directed, removed all stains and restored the car perfectly. With regard to the other problem—fingerprints—we just learned to close the gull-wing doors with what my doctor husband calls the hypothenar eminence of the hand (the karate-chop part).

Susanne Toeller, Hale, Mich.

Corrections: An incorrect address for ASHRAE (American Society of Heating, Refrigerating, and Air Conditioning Engineers) appeared in July's "Alternate-Energy Answers." The correct address is 1791 Tullie Circle N.E., Atlanta, Ga. 30329.

Two sharp-eyed readers noticed that the Sony Profeel VCR recorder and tuner/timer in the June article "Component TV" had their cover panels reversed—which only proves that the field is changing so fast that even Sony is confused. A follow-up story is in the works.

The "Windmills You Can Buy" buyer's-guide table in the July issue included an incorrect price. Bertoia Studio's A.P.S./H. wind generator costs $7,500. PS

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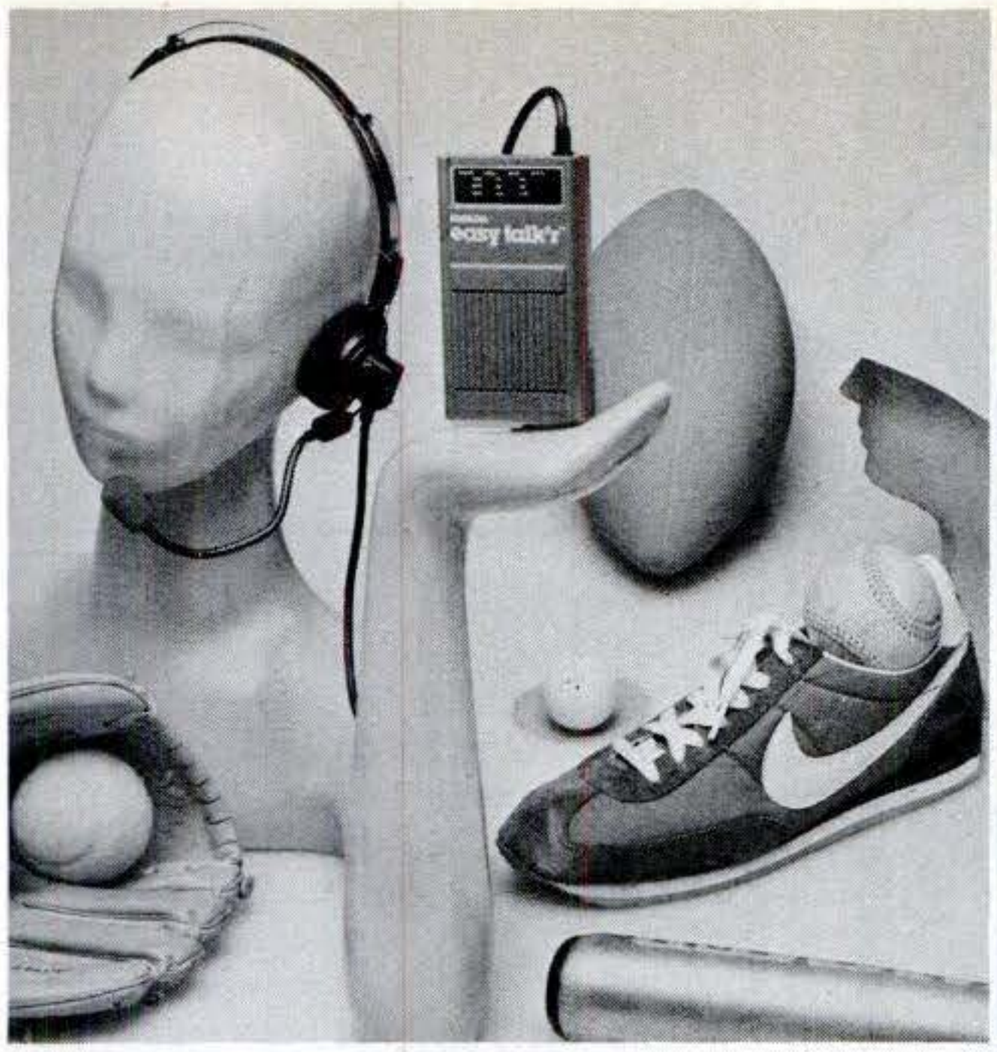

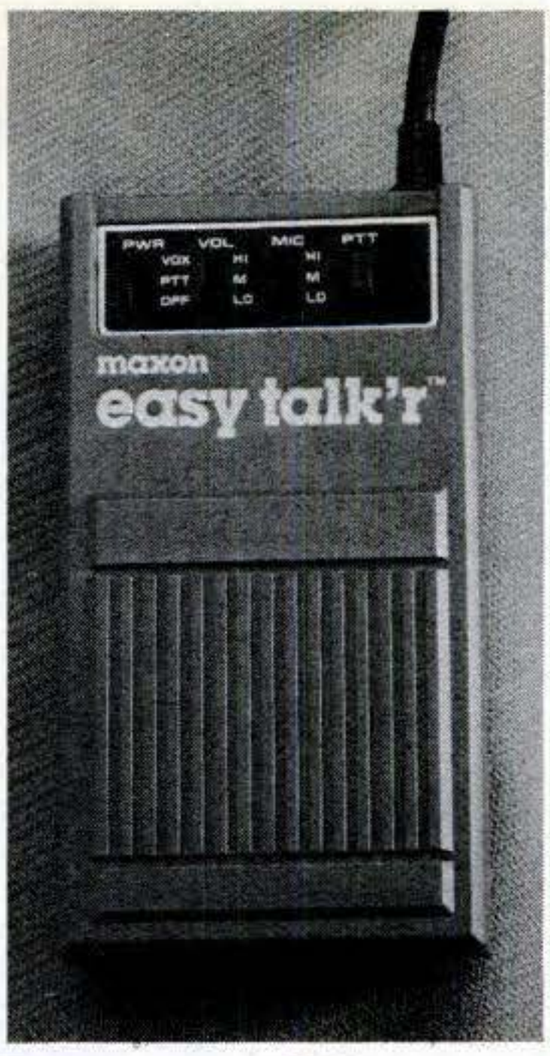

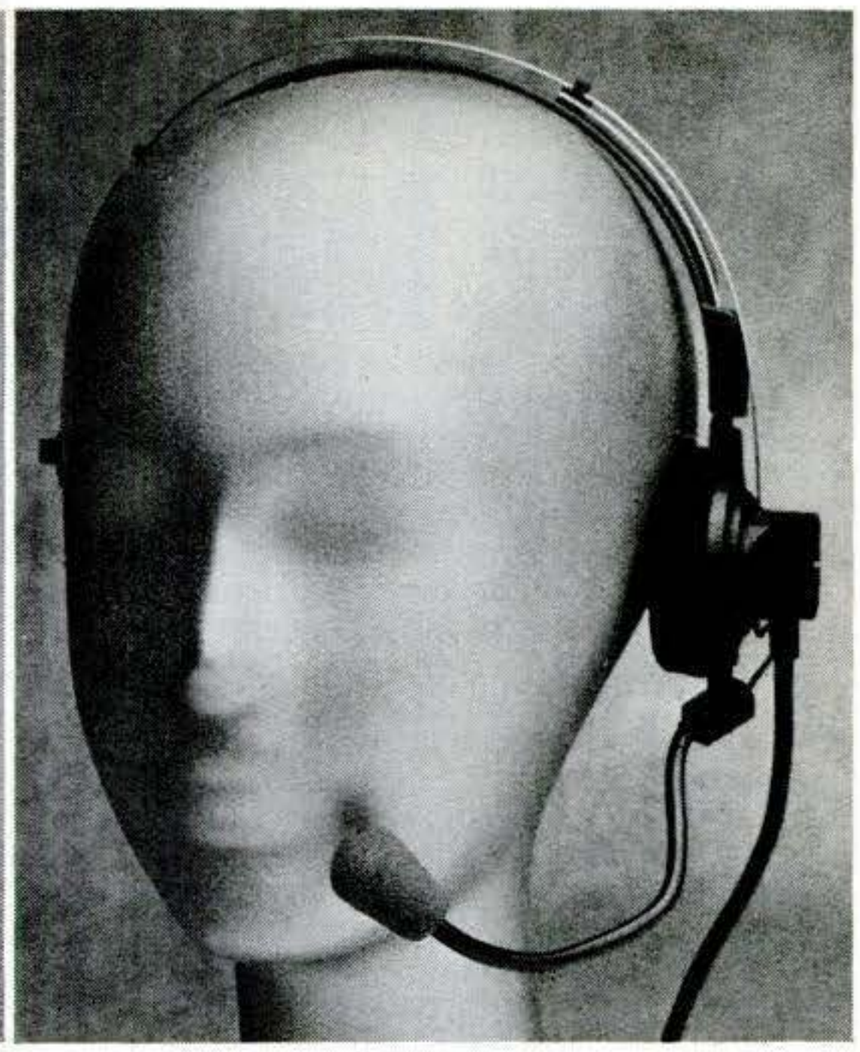

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NOT A WALKIE TALKIE

This is no toy. The Think Speak is totally automated. When you speak, a special voice activated circuit (VOX) automatically engages the transmitter so you are broadcasting. When you stop speaking, it automatically returns to 'stand by' to await a reply.

It is virtually noise free because it uses a quartz crystal locked dual conversion superheterodyne communication circuit that operates on an FM band.

So, your communication won't sound like a CB or an AM radio. You'll speak and hear with the full power and clarity you'd expect from an FM radio station.

HERE'S WHAT IT IS

You wear the Think Speak just like a personal stereo. There is an adjustable headphone that you wear on either your right or left ear. The other ear is clear to hear the outside world for safety.

A flexible boom microphone lets you speak normally while you transmit. The entire shaft of the boom mike is adjustable and will retain any position you set.

All of the electronics are contained in a small 6½ oz. case that easily clips to your belt or with its removable clip fits into your pocket. And, what controls.

The voice activation circuit has a 3 level sensitivity switch. If you're riding a motorcycle or breathing hard while you jog, you can set the sensitivity to low so that you won't transmit in error.

If you are hunting or fishing and you can't talk much over a whisper, you can set the sensitivity to high. Plus the headphone has a 3 level volume control too.

In addition to the VOX voice operated circuit, you have 'PTT' which means Push to Talk. When you want to talk, you just push the PTT button.

This is a really great feature when you want to whisper very quietly below the threshold of even the high sensitivity setting of the Voice Operated Circuit. You may be into surveillance or photographing wildlife. When you can only whisper, you'll especially appreciate the super quiet FM reception of this system.

SOME SPECIFICS

You can expect long battery life from a standard 9V battery (not included). In the 'stand by' mode, the Think Speak only consumes 13.5 milliamps of power while it's ready to transmit or receive.

The antenna is conveniently clipped to the headband for normal use. For full range use, the antenna pops up.

The system operates on the 49 mhz band using FM so you shouldn't be bothered by any other radio transmissions as you are with CBs and Walkie Talkies.

There are 5 channels (A-E) allotted to the Think Speak to further prevent interference. We will ship all units ordered on each order with the same channel.

The transmisssion output is a full RF of 10,000uV/m @ 3 meters max. No FCC license is required. And, the FM hum and noise is almost good enough for a high fidelity system at 40db min. The case is 4-9/16" x 2¼" x 15/16".

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You can talk to 1 or even 10 people with Think Speaks. So, if you're the head of a Search and Rescue team you can talk to everyone at once and get responses from one at a time.

The Think Speak is great if you're skiing with a friend, using two boats on a lake or at sea, hiking in the mountains or just jogging around the block.

If you're a pitcher you can talk to your catcher or the coach. If you're on a loading dock, you can talk to the man in the truck or on the forklift. If you're a security guard, you'll never be alone.

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Like the Vermont dealer who ran one ad in Sports Afield magazine. His ad pulled 22,000 orders—over A HALF MILLION DOLLARS IN CASH!

Yes, Mail Order is the fastest-growing, most profitable business in America! And now with the population explosion . . . the huge teenage market . . . and more people moving to the suburbs—we are on the verge of the BIGGEST BOOM in Mail Order history!

Free

If you are sincerely interested in starting a lucrative business of your own ACT NOW! We can help you get rich in Mail Order just as we've helped others. Mail the coupon or send a postcard. We'll send you a free book, catalog, ads and complete facts about our offer. No salesman will call. No obligation. You don't need previous experience but you must be over 21. Write to:
Mail Order Associates, Inc., Dept. 942
Montvale, New Jersey 07645

Mail Order Associates, Inc., Dept. 942
Montvale, New Jersey 07645
Please rush full details immediately.

*Name*_____
*Address*_____
*City*_____
*State*_____ *Zip*_____

Low-cost detector measures home heat loss

A new device costing under $40 brings do-it-yourself energy audits within reach of homeowners. Called Snoop, the battery-powered device measures heat loss and gain from both conduction and air infiltration. Mounted in the end of its barrel is a thermistor whose electrical signals are amplified and displayed on an output meter. You read heat loss or gain in units that can be converted to approximate R values by referring to a chart supplied with the unit.

Snoop has three sensitivity settings—HI, LO, and DR—that allow it to measure a wide range of conductive losses. The DR (draft) setting also measures infiltration losses around windows, doors, foundations, and electrical outlets.

Snoop's manufacturer recommends that the temperature difference between inside and outside surfaces be at least 30 degrees for reliable readings. An outside temperature of 90 degrees or higher is required to measure heat gain. Despite these limitations I found that Snoop works well, giving accurate readings of temperature differences.

You first adjust the meter to zero. Then, with the sensitivity switch set on the appropriate range, press the unit against the surface to be measured. Pull the trigger, and in about 15 seconds the meter needle comes to rest. To measure a draft, set the switch on DR and hold the thermistor about an inch away from suspected leaks. I found Snoop as sensitive to drafts as a candle.

Snoop is made by Environment/One, Box 773, Schenectady, N.Y. 12301.—*Mark Bittman*

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The $7 Push Button Phone

Plug in and start pushing. Now you can have highly automated phones with no monthly service charges for just $7 each. But, there's a catch.

Send back your dumb phones. Now instead of paying monthly service charges you can have push button dialing, last number redial, mute, and ringer off.

You can forget big clunky phones. You can also forget dials. This phone works perfectly whether you now have rotary or push button phones.

Now for just $7 you'll have the latest technology at a price that'll let you have a phone in every room in your home. But, don't forget there's a catch.

NOTHING TO INSTALL

Simply plug this phone into any standard modular phone jack and start talking. If you don't already have jacks, call your phone company.

They may even put them in free for you. Due to the recent Supreme Court ruling, soon they'll probably be selling you your own phones anyway. And, at worst, there's just a small one time fee.

LAST NUMBER REDIAL PLUS

It's really neat. If you call a number and it's busy this phone will automatically redial the number for you each time you touch 'redial'. There's no need to keep dialing over and over again.

When you need to speak privately to someone with you, you don't have to cover the mouth piece. Just press the mute button and the person on the line will be cut off for privacy.

When you want to take a nap, just switch the ring off and the phone won't ring. There's never a need to take your phone off the hook again.

The quality is great. A high quality condenser microphone lets the person you talk to hear you loud and clear.

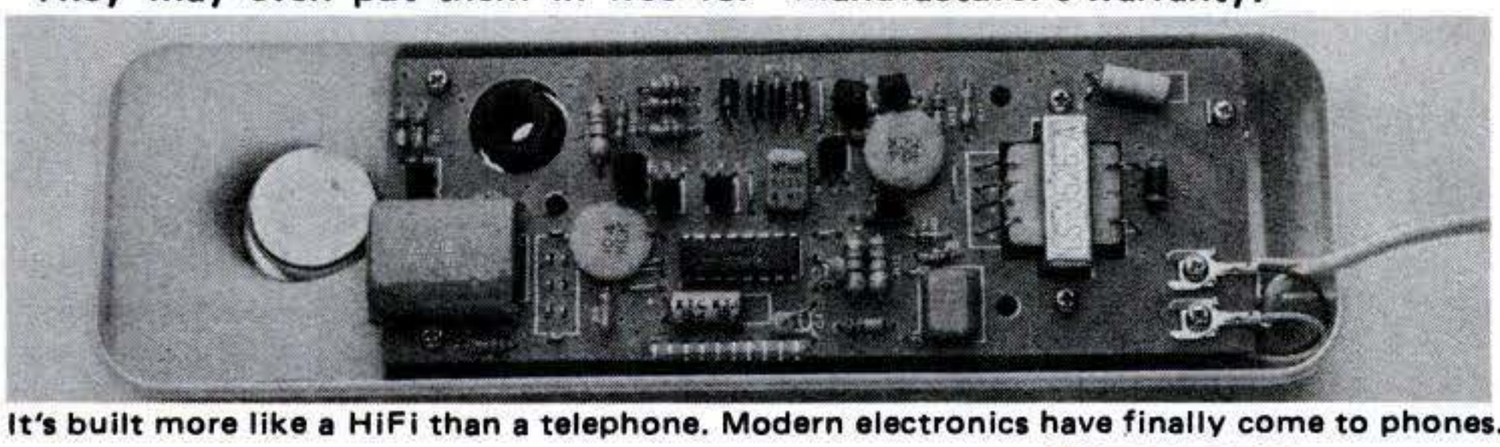
And you hear them through a high quality speaker instead of the old diaphragm 'thing' that's been in phones for 20 years. Even the electronic ring is new.

But, the nicest part of all are the push buttons. Once you've started using buttons you'll hate dialing the old way.

With this phone you can push the buttons as fast as you want. Then the phone sends out pulses on your line that work with virtually any phone system.

So this phone works anywhere. You can unplug it and move it from room to room or house to house in seconds.

The phone automatically hangs up when you set it down or you can push its 'hang up' button. It comes complete with a 14 foot coiled cord and a limited manufacturer's warranty.



It's built more like a HiFi than a telephone. Modern electronics have finally come to phones.

THE CATCH

Frankly we are losing our shirts on the automated phone, but we're looking for audiophiles who use audio cassettes.

If you buy top name TDK and Maxell cassettes, you probably pay $3.50 to $4.50 each for a 90 minute cassette.

We want you to try DAK's new Gold Label MLX ultra high energy, normal bias cassettes. Not at $4.50 or even at $3.50 each, but at a factory direct price of just $2.49 for a 90 minute cassette.

We challenge you to compare the frequency response, dynamic range and signal to noise ratio of our new Gold Label MLX to Maxell UDXL or TDK SA. If they win, we'll not only give you back your money, we'll give you a free gift for your trouble. And, DAK's come with a deluxe hard plastic box, index insert card and a limited 1 year warranty.

WHY, YOU MAY BE ASKING?

You're very valuable to us in the form of future business. Over 150,000 customers have responded to bonuses like this. We find most of you keep buying once you've tried our cassettes and our prices; and that's a gamble worth taking.

NOT A BAD CATCH

DAK manufactures a cassette with no problems and great sound. We've been hot on the heels of the frequency responses of Maxell and TDK. The tape we made last year had a great frequency response up to 14,000hz.

Now our new Gold Label MLX is second to none. We have a frequency response to 19,500hz and we'll go head to head against any tape on the market.

TRY NEW DAK MLX90 CASSETTES RISK FREE

To get the automated phone for just $7, try 10 MLX high energy cassettes. If you aren't 100% satisfied, return only 9 of the 10 cassettes and the phone in its original box within 30 days for a refund. The 10th cassette is a gift for your time.

To order your 10 Gold Label DAK MLX 90 minute cassettes and get the automated phone for only $7 with your credit card, call the DAK toll free hot line or send your check for only **$24.90** for the tapes, plus **$7** for the phone and **$3** for postage and handling for each group. Order No. 9416. CA res add 6%.

An automated Phone for $7 and DAK's new improved MLX. Time to stock up.

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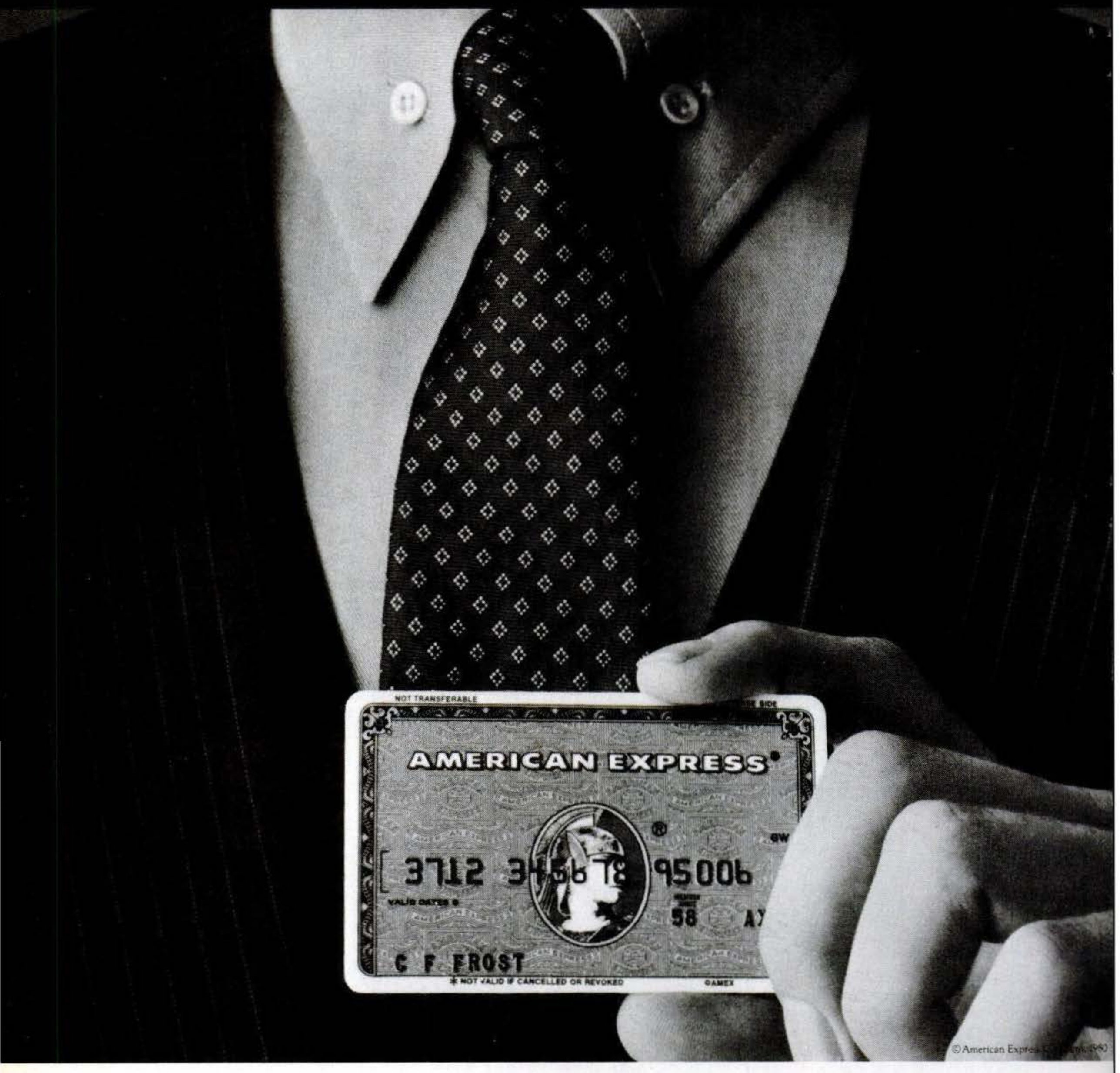
To get anywhere in business, it takes a little application.



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And unlike bank cards, there is no fixed limit imposed on your spending with the American Express Card.

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There's so much more. But if you ever wonder how so many successful people got to where they are, it just could be that the Card helped them get there.

And for you, all it takes is a little application. If the attached one is missing, just phone toll-free 800-528-8000 and we'll send you another.

The American Express® Card. Don't leave home without it.℠

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With Elmer's Carpenter's Wood Glue, building like a pro can be child's play.

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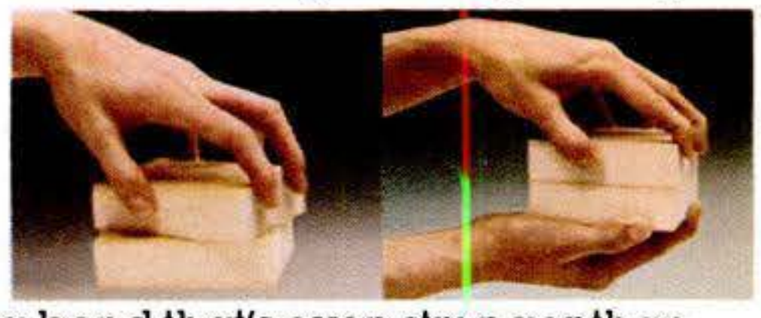
Specially made to penetrate both hard and soft woods, it grabs instantly, yet you can still realign the joint before it sets. After drying, it forms a bond that's even stronger than the wood itself.

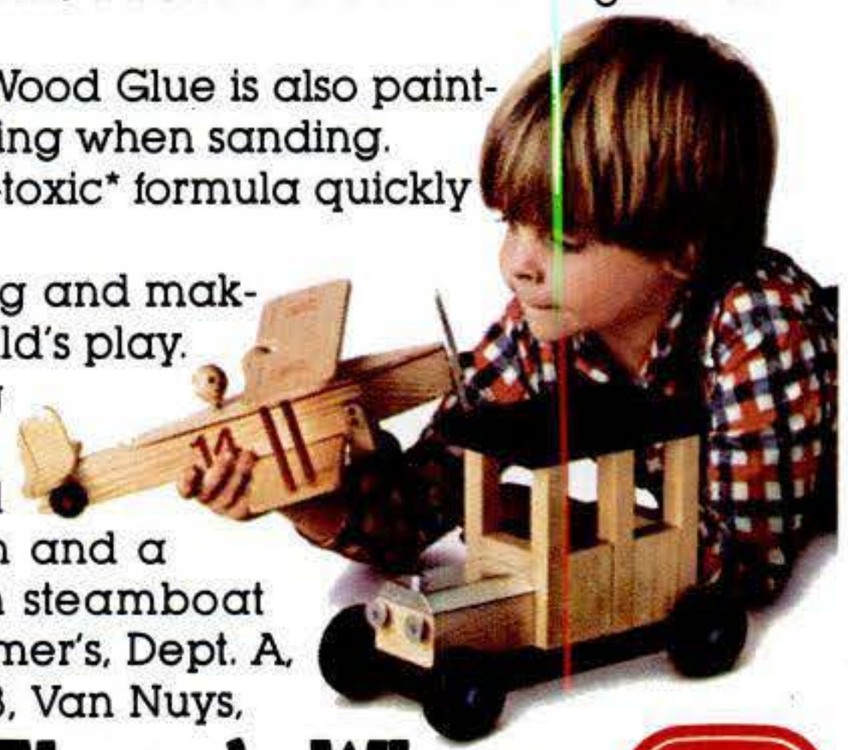
Grabs instantly Aligns easily



Elmer's Carpenter's Wood Glue is also paintable, resistant to gumming when sanding. And its solvent-free, non-toxic* formula quickly washes off with water.

To help make mending and making things like a pro...child's play.

For plans for making these beautiful wooden toys—the antique car, and biplane shown and a paddle-driven steamboat—send $3 to Elmer's, Dept. A, P.O. Box 2383, Van Nuys, CA 91409.



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DETROIT REPORT

By JIM DUNNE

AMC XJ

American Motors' XJ, a four-wheel-drive Jeep-type line that will be introduced early next year, looks bigger than it actually is. The difference is important. XJ is smaller than the Wagoneer and Cherokee lines, bigger than the CJ Jeeps. In AMC's plans, it will initially replace the Cherokee. Later it will probably take over the Wagoneer slot, too. It has a more modern, cleaner look than the Cherokee; it's actually more like the British Land Rover. It is 1,000 pounds lighter than the Wagoneer and 21 inches shorter overall. That adds up to a neater package for off-road trips. It also means that the standard 2.5-liter four-cylinder engine will achieve up to 25 mpg in city driving when equipped with the optional five-speed manual transmission. XJ will have a hatch opening at the rear, despite the objections of many inside the company who favored a drop tailgate with retractable window.

No Buick exclusive

Buick's rumored two-seat sports car will not be an exclusive. Instead, all five car divisions will have a version, though Buick's may be one of the most expensive. GM's product plans call for a two-seat sports car—code-lettered N—in the 1985 model year. Details are a closely held secret inside GM, but it is known that front drive, a high-performance four-cylinder engine, and luxury-level trim and appointments will be used. Price could be in the low $20,000 range.

Diesels doomed?

Diesel-car sales have dropped sharply this year, down 35 percent from 1981, and the future of the high-mileage engine is now being questioned. But diesel backers

Continued

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Detroit report

[*Continued*]

are not overly concerned. They point to the recent lower prices of gasoline and the narrowed price difference between gasoline and diesel as prime reasons for the plunge, and look for a rebound as oil prices rise in the future. However, the boom may be off, anyway: Gasoline engines are much more efficient than in the past, and with the proper gearing, they can nearly match diesel economy while offering a big advantage in performance. Other diesel drawbacks, such as exhaust smell and smoke, noise, and balky start-up in cold weather, are being ironed out, so the scales have not tipped completely in favor of gasoline engines. Look for diesels to be strong in narrow parts of the car market, such as taxis or other high-mileage, low-speed cycles, and for long-distance highway driving.

Vega started it

Now several automobile companies are using an all-aluminum engine-block technique. The Chevrolet Vega was the first high-production car to use an aluminum engine block without iron cylinder liners. Now some of the most prestigious car makers use the technique, and greater use is expected. The key to bare aluminum walls is using a high-silicon-content alloy such as Reynolds 390. It allows iron-plated pistons to slide over the walls without gouging or scoring the aluminum surface. Mercedes and Porsche now build engines with Reynolds 390 bare walls, and both companies are sold on the durability of the lightweight material. (In an experimental aluminum V6 engine the weight saving is almost 90 pounds.) Although the original Vega engine had severe overheating problems and its aluminum castings warped as a result, its pioneer technology led directly to the use of Reynolds 390 alloy in today's exotic engines.

Battery cars not dead

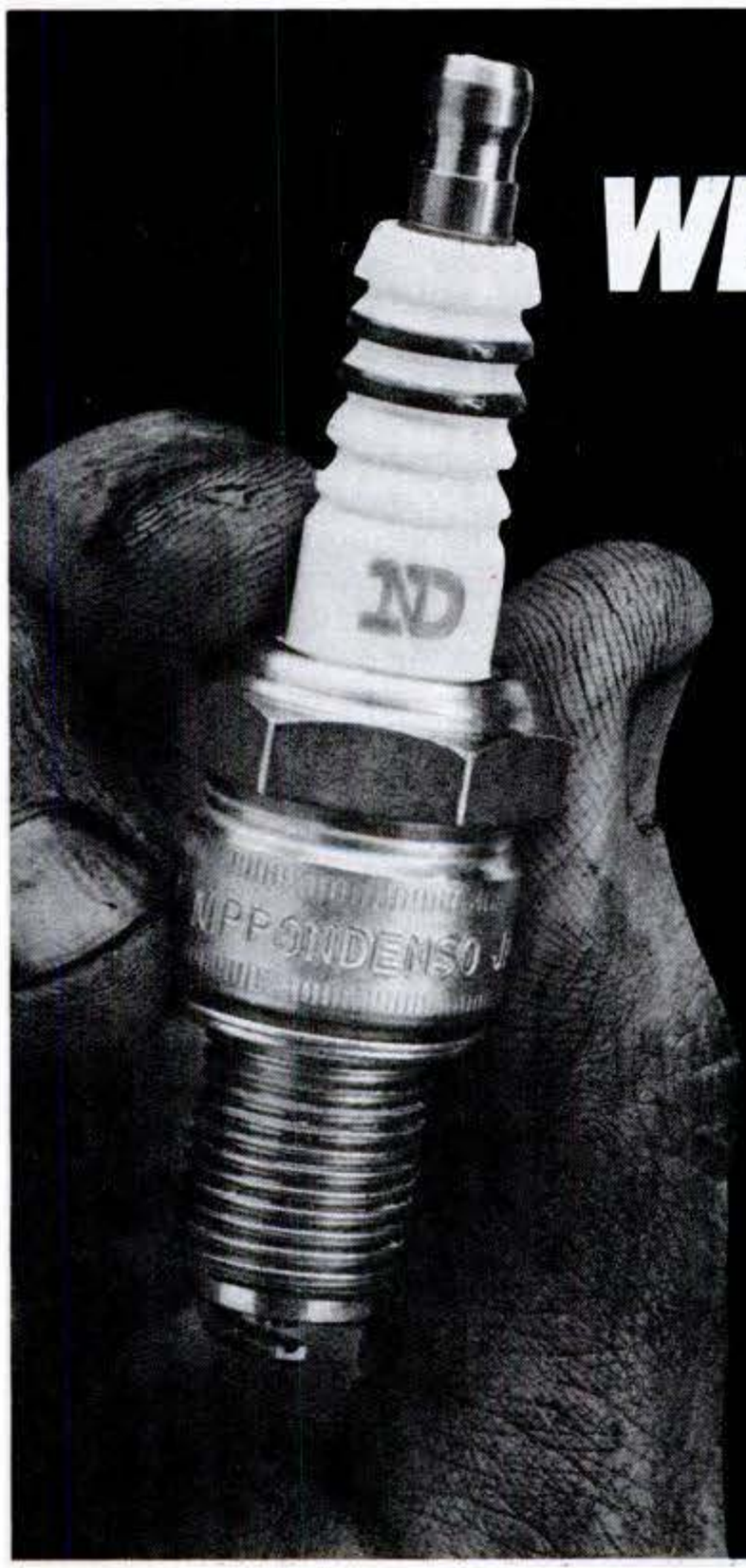
GM continues to develop systems for electric cars despite low public interest. The company is committed to long-life nickel-zinc batteries for future commuter cars. Using these is said to reduce battery size and weight by half when compared with lead-acid automotive batteries. GM is aiming at a battery pack that will last about 40,000 miles before replacement. And though the program has been set back from the targeted 1985, it is alive.

P gets green

Pontiac will definitely have the P-car ready for production in time for 1984-model introduction, and the sports car is expected to be the sensation of that season. The mid-engine two-seater has a familiar look by now, thanks to the rash of spy photos taken during its extended development. Basically, it is a wedge-shaped notchback with sharply sloping hood and hidden headlights. The engine lineup originally consisted solely of Pontiac's own 2.5-liter four. But now there is talk of using the 1.8-liter OHC four, which Pontiac uses in its J2000, as the base power plant, with the 2.5- and 2.8-liter V6 as performance options. Ten-second zero-to-60-mph times are expected. Three kinds of plastic will replace sheet steel in the body: soft covers for front and rear bumpers, injection-molded panels for lower body sections, and a sheet-molding compound for larger body parts. Look for the P, tentatively named Sunfire, to compete against the Mazda RX-7 in the $12,000-plus class.

GM CVT in 1985

That's the schedule for the first production in this country of a continuously variable transmission (CVT) for passenger-car use. GM's Hydra-Matic Division will build the unit for small cars first. But eventually, the CVT will be used throughout the GM car lineup. Look for Ford, Chrysler, and AMC to quickly follow. CVT offers a near infinite number of gear ratios in a direct mechanical linkup between the engine and differential, thus allowing an on-board computer to pick the best setting for fuel economy or performance without being restricted to four or five gear positions. PS



WE'RE NOT JUST ANOTHER FLASH IN JAPAN.

It's true that Nippondenso Spark Plugs are original equipment in Toyota, Honda, Subaru, Mazda, and other Japanese cars and trucks, as well as on Suzuki, Yamaha, Kawasaki, and Honda motorcycles.

But then ND plugs also meet the factory specifications for major American and European makes as well.

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To order any standard ND Spark Plug, send $2.05, plus .50c shipping and handling, to: Nippondenso of Los Angeles, Inc., Customer Service Dept., 857 East 230th Street, Carson, California 90745 (California residents add 6% sales tax.) Be sure to specify the make, model, and year.

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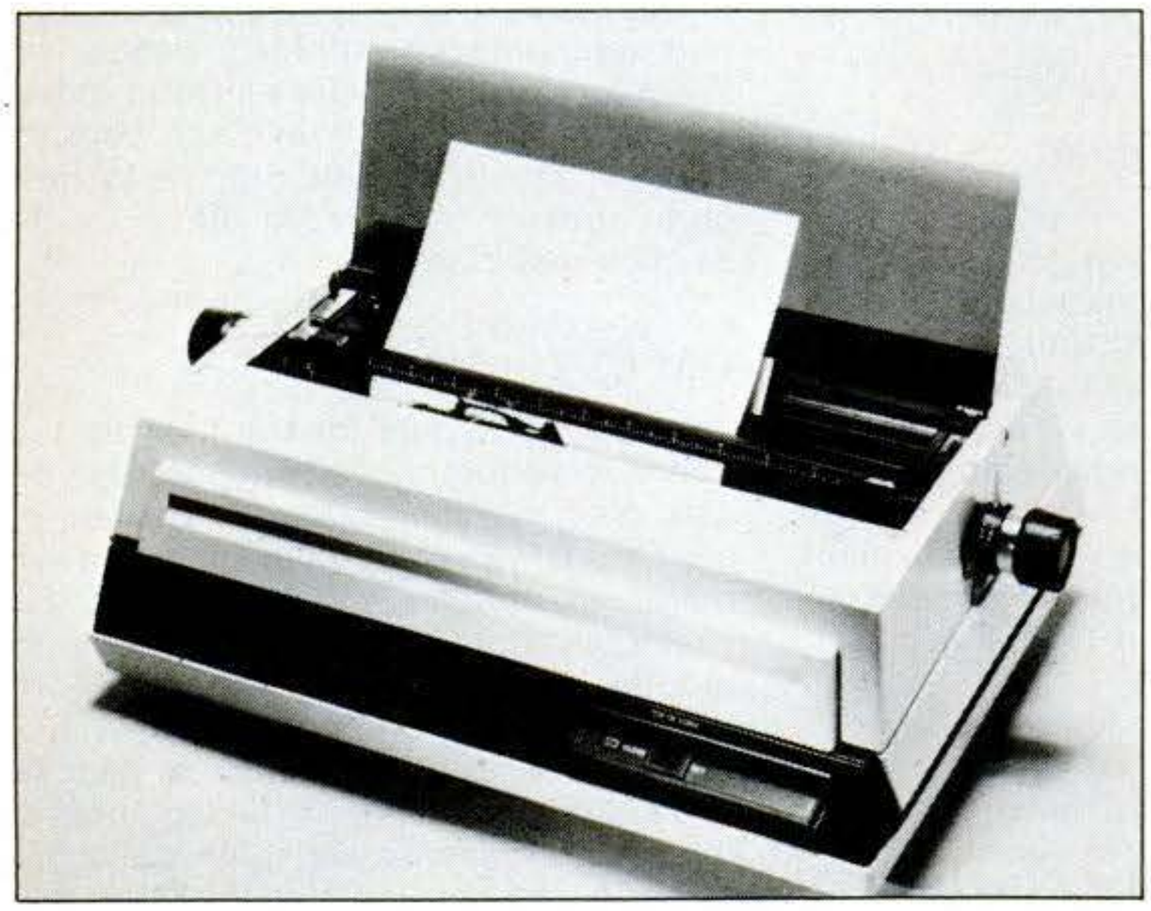
BITS & BYTES

By WILLIAM J. HAWKINS



An add-on you'll need

They're symptoms you should be aware of: sweaty palms, bulging eyes, an itch in the pocket that holds your cash. They're the first signs that you're serious about buying a computer.

Be forewarned, however, that there is a hidden charge that most people gloss over: the printer. I know—you don't *really* need one. But you don't *really* need air in your car tires, either. Fact is, without a printer any computer is severely limited.

There are three major points to consider when buying a printer: speed, print quality, and, of course, price. Each can vary enormously, but recently I got to try one that has an edge over other models in two of those three categories: print quality and price.

It's called the TP-1 (top photo), and it's not only SCM's first computer-oriented product; it's the first letter-quality printer available for under $1,000—it's $895. (Most letter-quality printers are at least $2,000.)

It uses a daisy-wheel print head for (if you'll pardon the expression) IBM-typewriter quality. And the print head is changeable: Up to six different type faces—from Tempo to script—can be used. However, the print spacing—10 characters per inch (pica) or 12 characters per inch (elite)—is not changeable. You must specify the one you want when you buy.

When you first turn on the printer, it comes alive: The print head shuffles across the paper and an electronic "beep" sounds as it automatically sets default margins and tab positions. (These may be changed at any time by your software.)

At present, the TP-1 takes single sheets of paper. A pressure plate holds it in place. But SCM plans to have a tractor-drive option shortly (for fan-fold computer paper) at a "moderate" price. (It's usually about $200–$300.) And the printer is already equipped for it: A front switch lets you set the top-of-form position. From then on, the printer automatically advances to the top of the next sheet when it nears the bottom of the first. That prevents printing over the "tear" area on fan-fold paper.

Besides excellent print quality, the machine is no noisier than an electric typewriter. That's rare with most of the printers I've tried. Control codes (from your software) not only reset margins and tabs but can backspace the head for special printing needs or do an automatic underlining of text.

The TP-1 is a good printer for business use—letters and other textual material. But for "computer people" it has a couple of problems.

It will only print up to 126 characters per line. This is more than most conventional printers (with 80) but just shy of 132—the standard computer-paper width. Also, the unit will not print the "greater than" (>), "less than" (<), or caret (^) characters. These are essential for printing out most computer programs.

Two other problems could be lethal to any operation. For one, the printer *always* does a line feed when it receives a carriage-return code. And it does a line feed when it receives the line-feed code. If your computer routinely sends a line feed with a carriage return, the printer will double space every line—there's no way to stop it unless you can suppress it in your computer.

Its second problem gets us back to the beginning: speed. At 12 characters per second, it's as fast as any human, but agonizingly slow by computer standards. One way around this, however, is to use the second item you see (bottom photo), the Super Spooler.

Two jobs at one time

Super Spooler is a very clever box you install between the computer and printer. When you do, all data you'd normally send to the printer is quickly snagged in the Spooler's 16,000-byte memory. (Data transfer rate is 3,000 characters per second using a standard "parallel" connection.)

In seconds, your computer returns you to normal operation since it "thinks" everything has been printed. That lets you continue to do other things. The Spooler, however, then begins to "feed" the printer. The typing begins, but at the same time you're doing something else.

A digital display on the Spooler shows increments of 1,000 bytes as they are received and sent to the printer. Buttons allow single-sheet paper to be used (the printer stops until you put in the next sheet and push the button), pagination (for skipping the "tears" in fan-fold paper), space compression (lots of spaces in your text are saved as one piece of data to conserve memory), and even self-test: The unit checks itself out and tells you if it's "OK" on the printer. The Spooler even accepts format codes in your text for such things as automatic margins, indentations, headers, or page numbers.

Spooler software programs are available for printing and working at the same time. They do it by sequentially sending a piece of data to the printer and checking the keyboard for action. If you type a character, data to the printer are momentarily stopped and the spooler passes your typed character to the right destination. It then continues to print. This happens so fast, however, it seems as though the computer is doing two jobs at once.

Spoolers work well, but the stuff you want to print must be pre-formatted to match the page and come from a disc file. It means once you start, you can't remove the disc. Super Spooler's hardware approach totally frees your system (discs can be removed, etc.). Also, the Spooler can be used for modems—another painstakingly slow piece of gear. (That requires the serial-connection option.)

Made by Compulink Corp., 1840 Industrial Circle, Longmont, Colo. 81501, it's $349 for the parallel type, $95 more for the serial option. Also, a 62,000-byte-memory option is available for $159. PS

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ALL-SEASON. ALL-TERRAIN. ALL-POSITION. ALL-GOODYEAR.

The Wrangler Light-Truck Radial.

One word describes the performance of Goodyear Wrangler Radials at this year's Baja 500 — incredible. First and second in the full-size pickup class. First, second and *third* in mini-pickups. All on exactly the same Wrangler Radials you can buy for your light truck.

Only Wrangler gives you the on- and off-road performance that iced the competition in the searing Baja heat. And Wrangler Radials are designed for a smooth ride and low rolling resistance. Which means you don't have to choose between a civilized ride and off-road ruggedness.

Wherever you work or play, go with the winner. The Wrangler Radial. At your Goodyear Dealer or Store.

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CHECK THE VALUE!!!

TWO SIMULTANEOUS TIME ZONES — Unique dual display with digital and LCD watch hands allows you to view two time zones at one glance. And you can set the digital display for 12- or 24-hour time.

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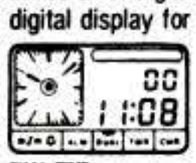
DUAL TIME

Time to the second, month, date and year are displayed clearly.

TWO CALENDAR DISPLAYS — Monthly calendar display (this month and next month) appears with a touch of the button, pre-programmed until the year 2029.

CALENDAR

PROFESSIONAL COUNTDOWN AND CHRONO — Ideal for tallying minutes on your parking meter, conference time, flight approaches or anything you like. The graphic chronograph and countdown timer functions alert you by sight and sound when the preset time is up. LCD hands indicate the minutes and second by one sweep per second (counterclockwise for countdown timer). 1-hour chronograph records split/lap/time to 1/100 second, and 1st & 2nd place time and then repeats. The countdown timer can be set for any time between 1 minute and 1 hour. Time repeats with a press of a button

COUNTDOWN ALARM

STOPWATCH

THREE-MELODY ALARM SYSTEM — Three different melodies (Dixie, Greensleeves, Clementine) plus "Big Ben" tune at noon, wake you, remind you and organize your day. Or you can substitute a 20 second signal for these computer melodies. Plus. . .this water-resistant wonder has a nightlight, precision quartz accuracy to ±15 seconds per month, a long-life lithium battery, one-year warranty and our 30-day money-back guarantee if not completely satisfied.

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PS readers report on

Home computers and solar energy

Here are the agonies and the ecstasies of working with new technologies

In January, POPULAR SCIENCE Editor-in-Chief C. P. Gilmore asked readers to comment on their experiences with solar energy and home computers. The reason? There had been reports in the media that most people were disheartened by their experiences with these two emerging applications of modern technology, and he wondered if the same held for readers of PS.

Judging from the response—for the most part—our readers get along nicely with both solar and computers (in some cases, at the same time). But there were exceptions. There seemed to be very little middle ground—those who wrote to convey a positive reaction were enthusiastic indeed, while many who had bad experiences with their equipment seemed almost soured on the entire venture. Here is a sampling of the letters we received.

THE SOLAR EXPERIENCE

Again? Yes!

Just two years ago I had a solar hot-water system installed, and I am very pleased with the results. Would I install again? *Yes.*

Richard B. King, Salem, Ore.

Problems of my own making

I could not be happier. We live at 5,600 feet in the mountains and get rather severe winter weather. My solar system heats my storage-tank water up to 160 degrees F, enough to totally warm the living-room, dining-room, and kitchen areas of our house. We have, with pure pleasure, shut off the gas furnace. The only problems we have had are a result of my own inexperience—I installed the system myself, and would know better next time. But I would rather have had a few problems from my own inexperience than have paid an installer thousands of dollars to hook up the system.

W. F. Kiesner, Frazier Park, Calif.

An overall loss

Several years ago I installed solar panels on my enclosed swimming pool. There is no question that fuel has been saved, but compared with the cost and maintenance of the panels there's an overall loss. Maintenance of panels, in addition to piping, circulating pumps, cost of operation, etc., must be taken into the system's cost accounting and is quite a negative value.

Walter B. Moses Jr., New Orleans, La.

Solar, 1; toys, 0

I am 100 percent satisfied with the solar heater I installed a year ago. Believe me, I've had fewer problems with my solar system than I've had with most of my kids' toys.

H. Allan Burns, Littleton, Colo.

Big and practical

I designed and built a fairly ambitious "three-way" system a couple of years ago and have had generally very good performance. I use it to heat water, for space heating, and as a spa heater. Gas bills during the summer are down to around $2 to $5 per month. My biggest gas bill during the year was $45 for one month.

John Oshon, Alamo, Calif.

Try, try again

After building one solar system that didn't work so well I thought about giving it up. But I tried again, and I have never been so happy and proud of anything I've done.

My first solar fiasco was very complicated—a system with pipes, antifreeze, heat exchangers, pumps, and so on, all of which was very impressive but just didn't work. My second effort was an air system. It wasn't as impressive, but does it ever work! I sure could show people what not to do when building solar collectors, as I think I've made every mistake possible.

Michael Hughes, Dacono, Colo.

Solar disaster

I am very much dissatisfied with the in-

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[*Continued*]

stallation of my solar hot-water system, but not with the idea. The careless way the contractor put up the system is the problem. The plumbing is so unorganized that when we have to work on the system, a major part of the piping has to be moved.

A. E. Krawcek, Leesburg, Fla.

Expensive troubles

I am a professional man, have read extensively about solar energy and the principles of its installation and function, and considered myself qualified to buy solar without getting into trouble. How wrong I was!

I selected a State of California-approved contractor and got everything in writing to have him install a sun-tracking domestic-hot-water unit. It worked like a champ in summer, but come winter, nothing. Now the contractor has vanished into the woodwork, leaving me with a $1,000 job to make the system perform adequately, lavish warranties notwithstanding. So much for standard precautions! I think I would have been better off to design my own DIY system.

Edwin R. Carnes, Upland, Calif.

Happiness is solar

I have had a solar water heater in operation for close to two years now. I designed and built it using ordinary materials readily available in any hardware store. The total cost was around $250. I am perfectly satisfied with the way it works, and the maintenance so far has been almost nil.

Henry Fischback
Mayaguez, P.R.

THE COMPUTER EXPERIENCE

An Apple at school

In reply to your request for reader input concerning home use of computers: I am using one, not in my home, but at the junior high school where I teach. It is an Apple II+ with the Mountain Computers music program. We have had some minor problems, though they are usually related to lack of user understanding. I am looking forward to the day when I have one in my home.

Paul Nelson, Bozeman, Mont.

Useful tool

I purchased an Apple II+ home computer with 48K memory, diskette reader, and matrix printer almost a year ago. My home computer is now the most useful appliance in my home. Reliability and quality were much greater than I had expected. I could go on and on . . . Suffice it to say that I will never be without a home computer.

Fred Van Valkenberg, Chicago, Ill.

Not for me

We have not had good luck with our computer system. Our problems have been poor equipment and poor programs. The manufacturer finally replaced the computer itself after four attempts to fix it. They admitted that they did not know how to test it to determine what was wrong. They simply tried this or that and told us to come get it. I have been programming since the early '60's and will continue to do so. Whether it is with this machine or not is debatable.

William H. Bosler, Houston, Tex.

All's well that ends well

My computer arrived in December 1977, and initially was a disaster. A lack of business programs and a shaky tape-file system almost made me abandon the idea. However, with perseverance I had an effective invoice system up and running, and for the first time in 25 years I could quickly determine my exact cash position. I now have a completely computerized office, a computerized check system, and a top-quality word processor that earns its cost three times over each month. I'm convinced that the ability to remain competitive in the current economic climate has been possible only because of my microcomputer use.

Theodore Lovell
Franklin Lakes, N.J.

Soured on it

I was delighted to receive a TI 99/4 as a Christmas present from a son in California. But as soon as I tried to enter the longer programs I found in various library books and magazines, it balked. I called TI and they had me drive to their "local" office to have my console and cartridges checked out. The system was faulty, they said. So I paid $47.70 for another (reconditioned) console. It didn't work much better. Now I'm soured on the whole personal-computer bit.

William E. Woods
Evergreen Park, Ill.

One for each

I have a pair of Heath H-89 computers. That allows me the use of one unit, while the other is permanently occupied by my wife—a condition that began approximately two months after acquisition. I don't know if this is a normal incubation period for adults—for juveniles, a period of three to six hours post-exposure is required for "computeritus" to develop fully. Other than a few minor worries, the only problems I've had have been listening to complaints from friends who own

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computer systems from other manufacturers.

Ben R. Ezzell, Abilene, Tex.

No future

When I bought my computer (just a small one, with 4K user RAM and 8K BASIC in ROM) I anticipated that it might help me a little in my business and give me the opportunity to learn something about computers. So far, I have learned that entering even simple game programs time after time through the keyboard can be tedious and time-consuming and that cassette storage and retrieval of program material is a chancy business at best. In light of the problems and expense, can you guess why most people will continue to use a pen and calculator (or just their heads) to balance their checkbooks?

Steven L. Christensen, Kanosh, Utah

What the doctor ordered

Originally, my system was bought to provide a hobby activity, to replace my home-built micro. I now have over 640 cataloged programs. For the most part, I use the system for correspondence and word processing, probably averaging less than five hours a week. But I love my system and enjoy both using and fixing it. It allows me to do some very interesting things, although most of them are admittedly unnecessary.

Milan D. Cherko, M.D., Raleigh, N.C.

Power problems?

We have never been able to use our computer system because we experienced system errors in the process of building our customer data base. There appears to be a lack of technical skill with engineers who service small computers. Most computer technicians in the field tend to be "board pullers"—they replace boards until the system works, without thoroughly investigating the problem.

John D. Brock, Nantucket, Mass.

Wrong store

A year ago I purchased a Radio Shack TRS-80 Model II with 64K, an expansion disc system and a daisy-wheel printer. Early on I regretted having purchased my system from the store I did. The personnel there reminded me of the old-fashioned used-car salesman: Say or promise anything to make the sale, and once the contract is signed deny everything. I do not believe this attitude is a reflection on the hardware or on all Radio Shack Computer stores. I'm happy with the system, would purchase it again (but from a different store), and only wish I had more time to work with it.

David L. Perkins, Sunnyvale, Calif.

Computer and solar plus

Three years ago I bought a North Star Horizon, 48K, two discs, and an NEC Spinwriter. I use the system for my mailing labels, some bookkeeping, and all correspondence. The computer is used an average of 30 hours a week, and I would be lost without it. There has been no failure of chips or memory. (I wish I could say the same for myself!)

A year and a half ago I built an air collector against the front wall of my house for about $250. It keeps one end of the house very livable whenever the winter sun is out. A second unit is under construction for the kitchen-dining-room end of the house because we are so pleased with the first unit.

Jim Fitzgerald, Atascadero, Calif.

Tips on both

I had a Solahart solar hot-water system (passive) installed last year at a cost of $2,350. The system has functioned flawlessly. It supplies 100 percent of my hot water from April through October without use of the backup electric heating element. (The power has been switched off!)

I also purchased a Radio Shack TRS-80 level I 4K computer at about the same time. Later I upgraded it to a level II 16K system and added an Exatron stringy floppy digital tape unit.

Having been a data-processing professional for 12 years, I feel qualified to make the following observations:

1.) As a class, computer-store salesmen demonstrate an appalling lack of knowledge concerning the products they sell.

2.) Software documentation, as a rule, is inadequate, poorly written, and not "user friendly." This is a tremendous problem for novice users.

3.) Only very few companies in the industry are prepared to respond to the demands of a large user base.

4.) Home computers are not "plug-'em-in-and-push-the-button" appliances. They cannot be marketed like stoves and washing machines. To do so will result only in disenchanted consumers.

Alec Burchfield, Glendale, Ariz.

Good all around

I have a solar water heater and a Radio Shack computer, and have had good experience with both. The water heater was manufactured by Grumman and was installed by a local contractor. It has been in operation for over a year, and I've had no problems with it.

My computer system is a TRS-80 Model I with two TEAC disc drives, a Radio Shack Line Printer IV, and a Radio Shack modem. I am amazed and delighted with what this little computer can do. I use the computer as a terminal to large mainframe computers for my work (I'm an engineer); as a terrific programmable calculator for keeping up with my stock portfolio; as a source of endless amusement playing games; as the best word processor I have ever used; and as a valuable tool in learning about microprocessors in general.

Joel Watson, Raleigh, N.C.

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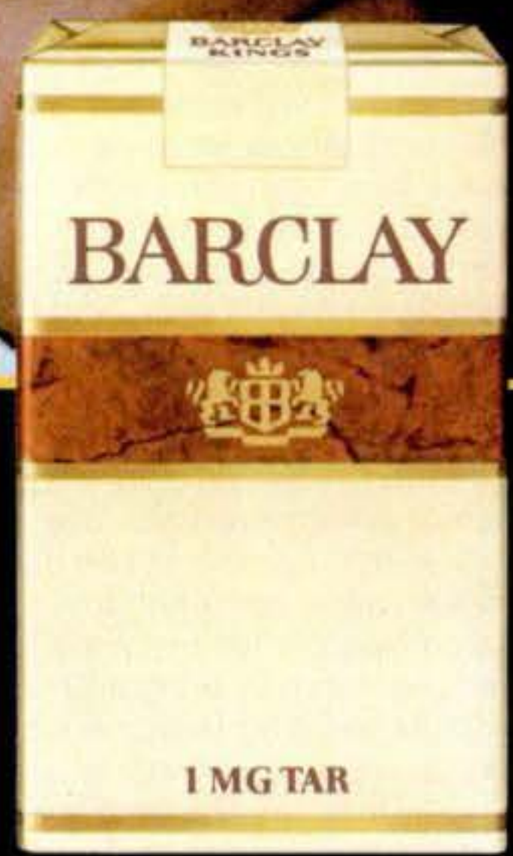

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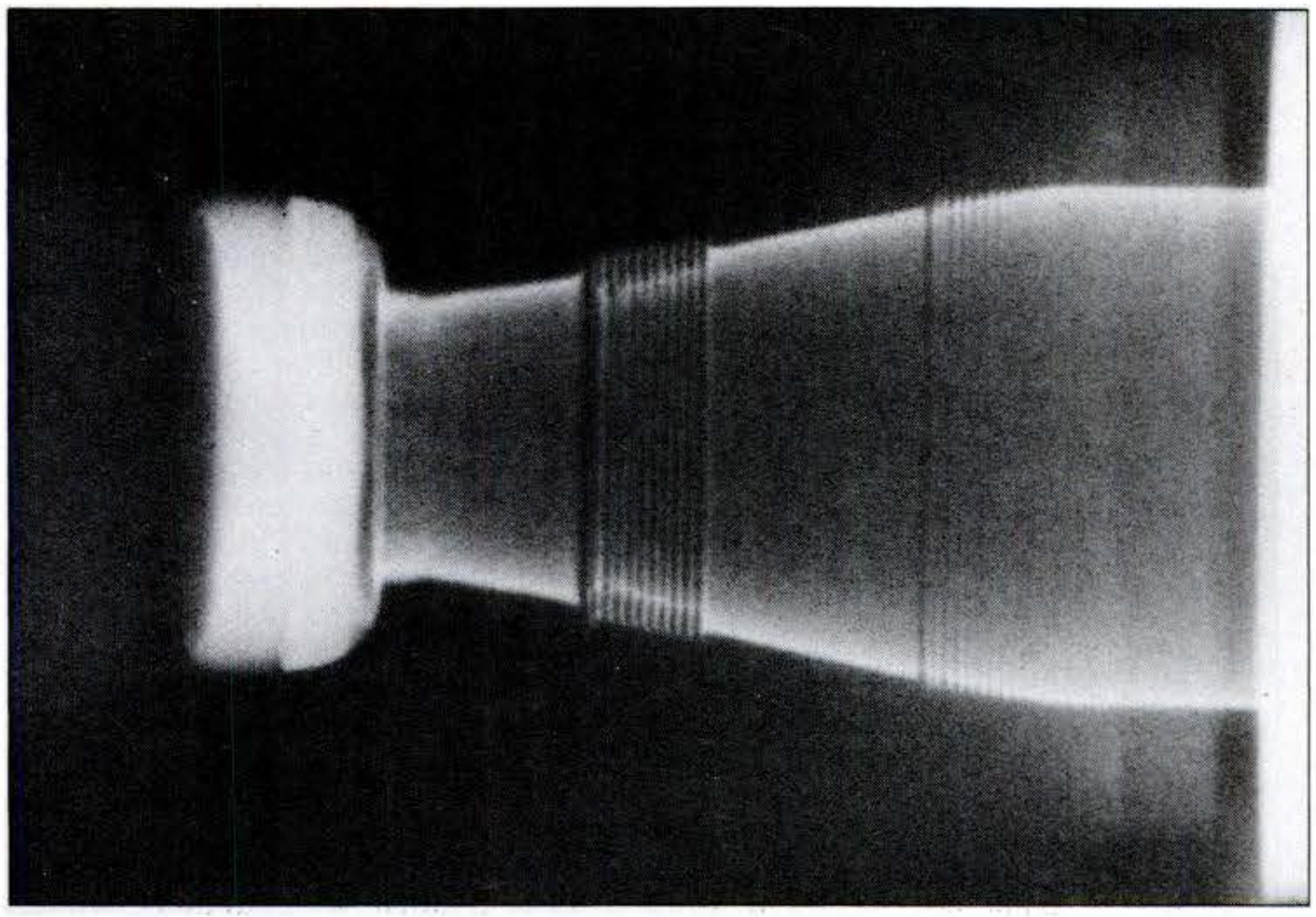
SCIENCE NEWSFRONT

By ARTHUR FISHER



Most powerful X-ray device

Pictures like the one above, called radiographs, will be made by a new instrument whose designers think will be a key bridge between the computer simulation of nuclear-weapons explosions and actual underground tests.

The device—the high-explosive flash-radiography facility (FXR)—is at one and the same time this country's most powerful electron-beam accelerator and X-ray source. It stands in a massive, 175-foot-long concrete building at the Lawrence Livermore National Laboratory in California. Its mission is to take clear pictures of what happens inside a nuclear-weapon component at the instant chemical high explosives are detonated within the object. This will enable weapons designers to confirm the predictions made by theory and computer.

The basic principle of flash radiography is similar to that of the medical X-ray, with several critical differences. The materials to be imaged are far more opaque than human tissues, and they are moving very fast at the moment of explosion (about six miles per second). Thus a very intense, very short pulse of X-rays must be used to snap the picture. The "flash" of X-rays is produced in this way:

At the core of the FXR is a linear-induction electron accelerator, consisting of 54 12-foot-high power modules. Six of the modules power the cold-cathode electron source; the other 48 accelerate the 4,000-ampere electron beam toward a target made of a thin tungsten plate. By the time it reaches the target, the beam is traveling at close to the speed of light and has an energy of almost 20 million electron volts; this means it delivers a blast of power equivalent to 80 billion watts. The blast stimulates the tungsten to emit a burst of X-rays, lasting only 60 billionths of a second; the cone-shaped spray of X-rays is aimed through an armored port, or "bullnose," at the test object some yards away. A complex electronic system allows an operator to choose the precise instant during an explosion to be radiographed. A cassette loaded with radiographic film, placed behind the test object, must be weighed down with heavy concrete blocks to keep it from being blown away during the blast. The massive concrete walls of the FRX building itself shield the accelerator—and operators—from the explosion.

European fusion

When the peculiarly shaped sections seen in the photo (bottom, left) are assembled at Culham, England, they will form an electromagnetic ring, 20 feet across, for the Joint European Torus (JET). This advanced thermonuclear-fusion experiment will use the familiar torus, or doughnut-shaped magnetic bottle, to contain a plasma at temperatures in excess of 100 million degrees C. The international project will require a power supply of 230 megawatts.

Lightning strike

The extraordinary photo below at right shows the leading edge of a helicopter rotor blade at the instant it is struck by a simulated lightning bolt. Experiments such as this one are becoming increasingly important as composite materials are being used more and more in aircraft to save weight. The reason: An all-metal skin gives an aircraft far more protection in the event of a lightning strike than glass-fiber or carbon-fiber composites, which are not as good conductors of electricity.

In the experiment pictured here, scientists at Culham Laboratory's Lightning Studies Unit at Didcot, England, generate pulses of current equivalent to severe strikes, which can affect not only an air-

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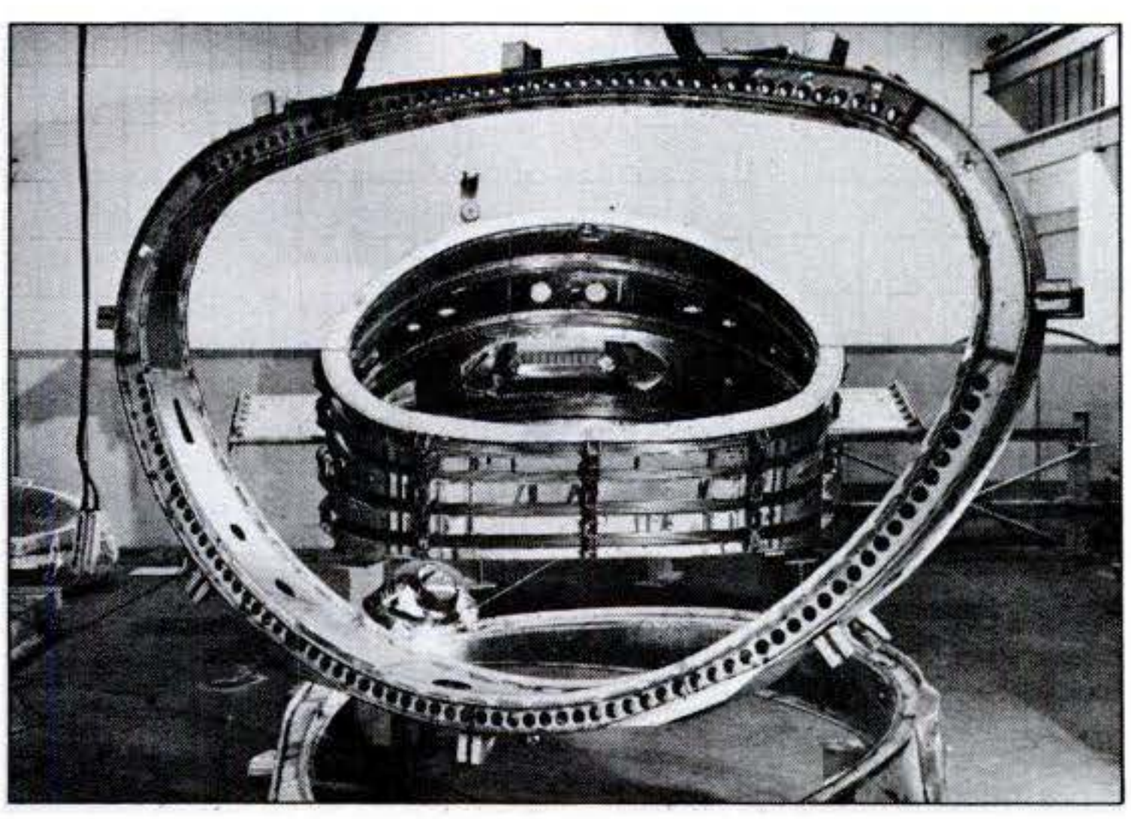

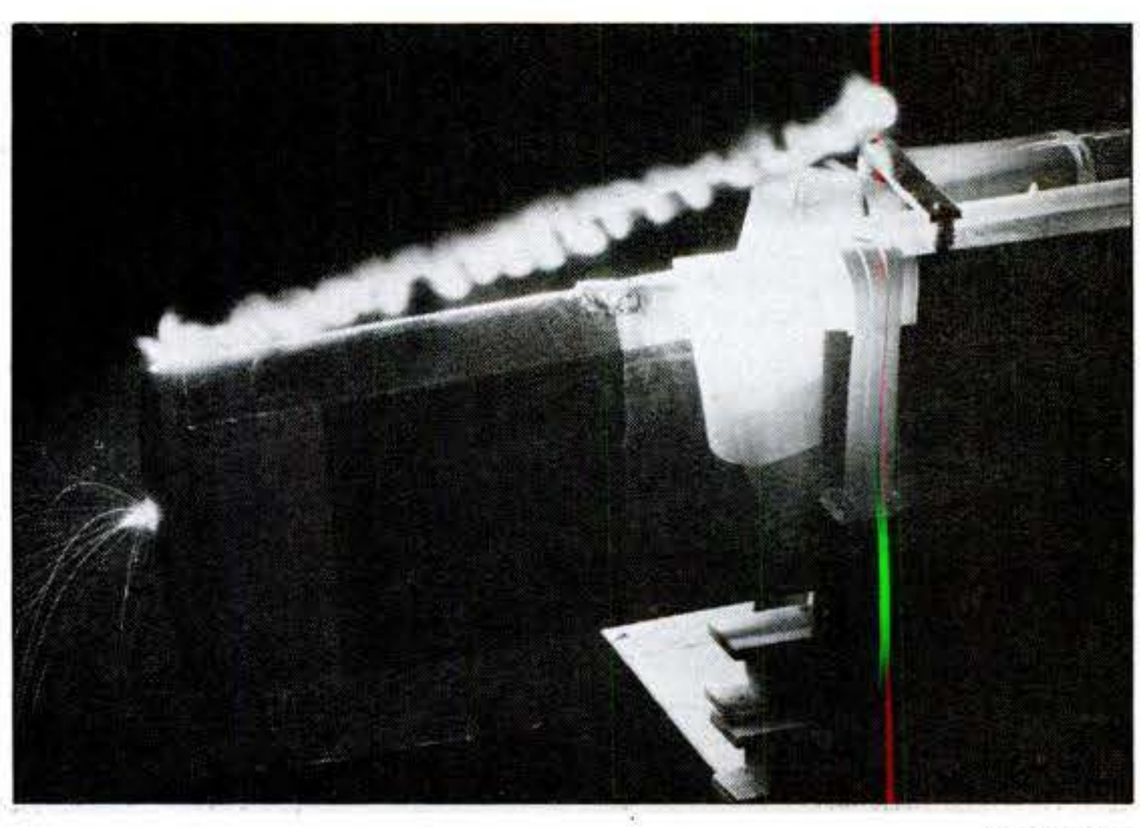

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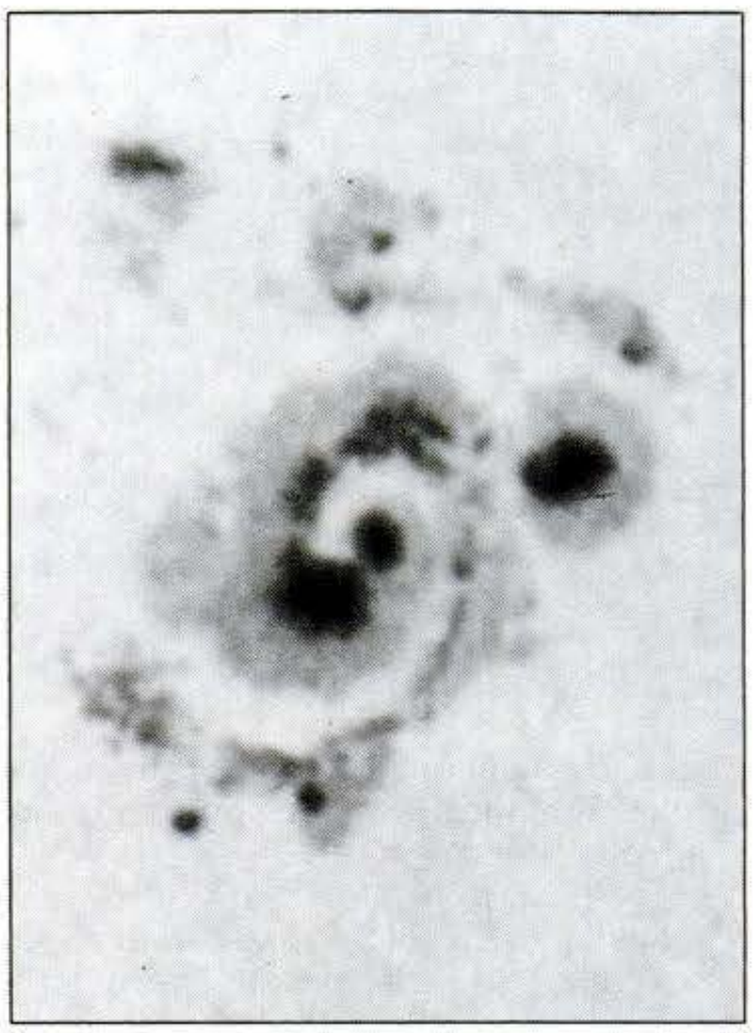
Spiral something

The something-or-other in this photograph, with its central core and whirling arms, is obviously a spiral galaxy, right?

Wrong. Despite its uncanny resemblance to them, this astronomical object is not a member of the family of spiral galaxies made familiar through thousands of



handsome telescopic images. It is, instead, a sunspot. It was first observed at the Kitt Peak National Observatory's Vacuum Solar Telescope by astronomers who could at first hardly believe their eyes. The unprecedented sunspot is also unusually large: 50,000 miles across, as contrasted with an average sunspot diameter of about 6,000 miles.

Solar physicists now believe that sunspots are cool areas (which is why they appear darker than surrounding regions) where the sun's powerful magnetic fields are concentrated. But a detailed analysis of how they appear, evolve, and disappear has never been successfully achieved.

Antarctic volcanoes

A Chilean geologist, Dr. Oscar Gonzalez-Ferran, has discovered two previously unknown active volcanoes in Antarctica. Dr. Gonzalez-Ferran was surveying, by helicopter, the east side of the Antarctic peninsula, which is even more terra incognita than usual for that remote region. The volcanoes have erupted so recently—one of them is still steaming—that the debris spewed out still litters the adjacent Larsen ice shelf. So far, five active volcanoes have been found in Antarctica, the highest being the notorious 13,000-foot Mount Erebus. Geologists say that the existence of still-active volcanoes here means that the Pacific crustal plate is actively moving under, or subducting, the Antarctic plate. This grinding tectonic process causes both volcanism and earthquakes. The so-called "ring of fire" is a violently active subduction zone that rims the Pacific Ocean.

Latest video heartthrob

The lexicon of high-technology medical procedures keeps expanding. The latest entry is "esophageal two-dimensional echocardiography," pioneered by two medical researchers, Dr. Nelson Schiller and Dr. Peter Kremer, at the University of California, San Francisco. They use a long, flexible tube to place an ultrasound transmitter in a surgical patient's esophagus, behind the heart. By manipulating the angle and position of the probe, they can beam ultra-high-frequency sound waves at desired portions of the heart. The echoes of these ultrasounds create a visual image of the throbbing heart that can be transmitted to a TV screen so that the patient's cardiac status can be monitored during an operation. Conventional echocardiography uses a sound transmitter that is held against the patient's chest; the UCSF researchers believe the new technique produces clearer and more informative pictures.

Diet and cancer

"The evidence is increasingly impressive that what we eat does affect our chances of getting cancer." So said Dr. Clifford Grobstein, chairman of an expert panel of the National Academy of Sciences, upon the release of this country's first really extensive report on links between diet and cancer. The Academy's 600-page report, "Diet, Nutrition, and Cancer," lists a set of guidelines for reducing cancer risk. They include eating 25 percent less saturated and unsaturated fat than is now typical in the American diet by consuming less-fatty meats, dairy products, and cooking fats and oils; avoiding most salt-cured, smoked, and pickled foods; eating larger amounts of whole grains, fruits, and vegetables. The report particularly recommended eating foods rich in vitamin C, because they seem to lower the risk of cancers of the esophagus and stomach; dark-green leafy vegetables and deep-yellow fruits and vegetables, because these rich sources of beta-carotene seem to reduce the risk of lung, bladder, breast, and skin cancers, among others; and vegetables in the cabbage family. But there is no recommendation to increase one's consumption of fiber as such, long a favorite panacea of some health advisors. The panel specifically counseled against taking high doses of vitamin or other nutritional supplements. It also recommended moderation in drinking alcohol, but without defining what a "moderate" level was. PS

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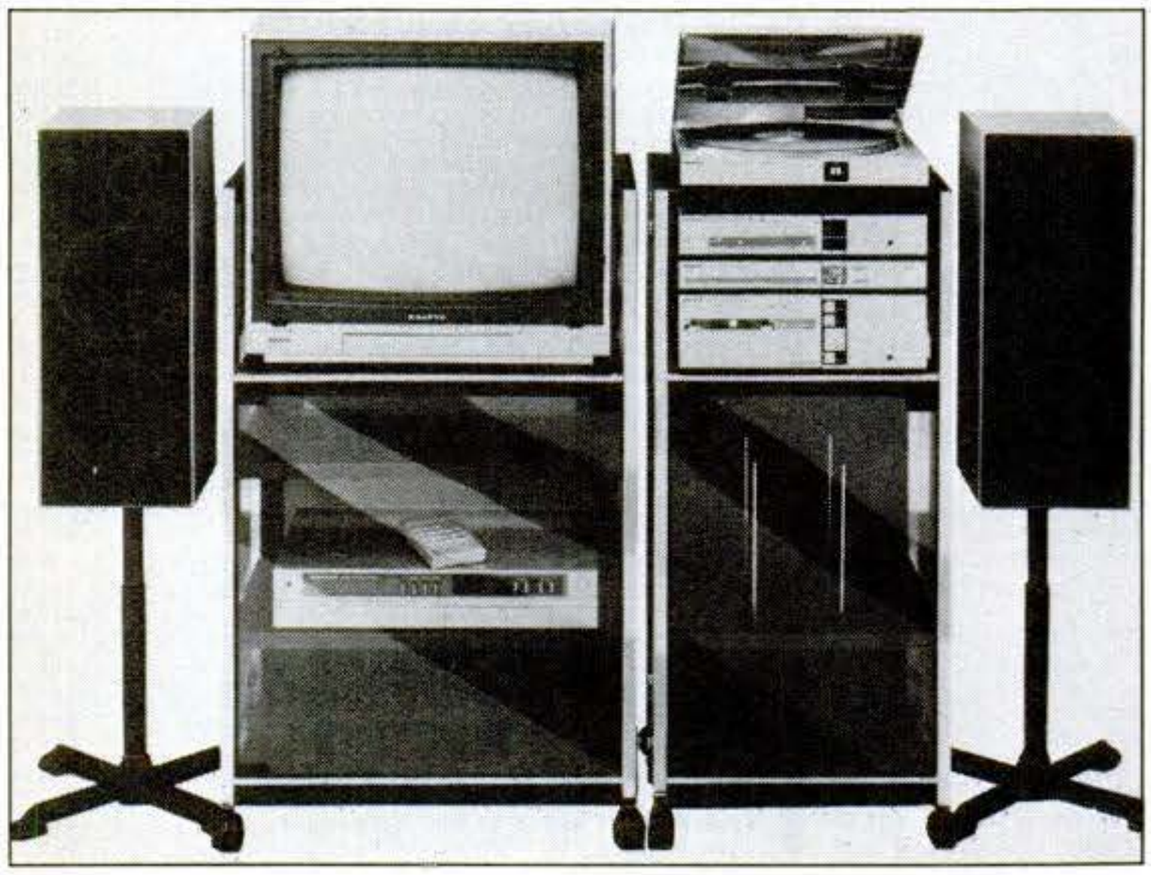

Stereo video systems

Television audio, limited by tiny, inferior speakers and mediocre amplifiers in most sets, has been undergoing a quiet revolution. Many firms have introduced console color TV's with stereo loudspeakers and special amplifiers in the last year or so. The improvement in sound, especially with stereo sources such as videodiscs and some cable or pay-TV sources, is significant. The consoles often have circuits for producing simulated, or pseudo, stereo, too.

Now come video-audio systems based on "packaged" components [PS, June]. Sanyo and Kenwood both showed modular video and audio hardware at the summer Consumer Electronics Show. Sanyo's Pro-Ponent series (above) includes a tunerless video monitor, but both systems feature control systems for integrating the growing maze of audio-video signals in the home—VCR's, videodisc players, cable TV, video games, and personal computers.

Sanyo's $400 AVT95 video-control system, for example, has a cable-ready tuner that accepts all these inputs and operates with a 17-button digital remote control. Its $600 color monitor has excellent 360-line horizontal picture resolution. Sanyo's System 33 audio components—amplifier, tuner, cassette deck, linear-tracking turntable—fit a caster-equipped component rack.

Kenwood, one of several audio firms moving into video, features audio amplifiers and receivers equipped for push-button selection and dubbing of video sources in its new video-audio systems. Kenwood doesn't have a video monitor but is offering a four-head VHS VCR. Buying a complete system like this, incidentally, doesn't make much sense unless the VCR is stereo, too. From now on, many prerecorded video tapes will be stereo releases.

RCA, in a New York preview of its fall line, showed that it's going the modular route, too. It's rolling out five new color-TV receivers with 350-line resolution and video-input jacks selectable by infrared remote control. The new ColorTrak 2000 consoles all have stereo amps and speakers, plus stereo inputs for disc, tape, or FM. RCA will introduce its stereo videodisc machine, plus new software, this summer. A line of stackable-furniture units is designed to accept video and audio components.

Some RCA color sets use a new slimmer picture tube with a 110-degree flare. The tube is 4.5 inches shorter than RCA's 90-degree tubes. For enhanced picture contrast, color pigments are added to the red and blue phosphor stripes to absorb ambient light.

Tiny VHS portables

You've probably seen Panasonic's ad showing Reggie Jackson holding a remarkably compact 8.5-pound VHS portable VCR. And Sony touts its compact Beta portable in actual-size ads. Now, as expected, JVC, developer of the VHS format, has shrunk battery-operated VHS machines still further. How about a 5.3-pound deck (battery and all) that measures 7¼ by three by 8½ inches?

JVC's new HR-C3U VCR uses a different type of VHS cassette, about the size of a deck of cards. The machine and tape record 20 minutes of material. Then you either play it back from the deck into a TV monitor or insert the minicassette in an adapter for playback on any other VHS deck. JVC calls the new format VHS-C. We'll detail it in a future issue.

Binaural helmet video

That lightweight VHS-C format from JVC is an intermediate step to still-tinier VCR's using narrower (¼ inch) tape in a single package with a color-TV camera. The continued trend in VCR miniaturization plus new products such as Sony's pocket-sized, thin-screen Watchman TV ["L&L," PS, May] lead to some speculation about advanced home-entertainment products that may be on the drawing boards.

First, what's needed is a digital HDTV portable VCR-camera. Translation? Several major electronics firms are readying high-definition TV [PS, Nov. '81]—systems with over twice the scan lines of conventional broadcast television and some five times the picture detail. Ultimately, HDTV will be encoded and recorded in a digital format. Computer-like signals permit cleaner, noise-free recordings, plus fantastic reductions in circuit size with very-large-scale integration. Some VCR models, incidentally, may use optical rather than magnetic tape. Optical tape has greater capacity for information density, and is encoded just like digital optical discs [PS, Aug.] with a finely focused laser.

Wide-screen Cinerama-type HDTV pictures pack a lot of visual impact. But something is lacking. You can't really appreciate the super-fidelity on HDTV picture tubes because of their size limitations. Projection HDTV is better, and seems like a must for group viewing. The Watchman and Walkman (personal portable stereo) generation, however, may find a personal viewing helmet more suitable. With a helmet-like entertainment center, the size of the image could be adjusted to fill your entire visual field, or reduced for less-imposing pictures. The 3-D model might be costlier, as will a 3-D twin-camera portable HD VCR.

Your helmet should have the ability to play either conventional stereo or, better yet, binaural recordings. With the latter, microphones are positioned to capture sound fields just like human ears. Playback through headphones can be startling, since the audio 3-D effect lets you hear sound from overhead and behind. Binaural recordings audibly transport you to the original recording site.

120-channel cable

As cables carrying TV signals are connected to homes in elaborate new systems, the hardware needed for the job grows in complexity. Zenith, which last year introduced its Z-TAC, an addressable multitiered cable converter system (photo), has been providing options that make it still more sophisticated. A solid-state

memory in the decoder gives it a unique address, enabling cable operators to remotely switch decoders or channels on or off.

Z-TAC systems range from addressable converters with 54 channels to twin-cable, 120-channel decoders with infrared remote control, plus text and interactive

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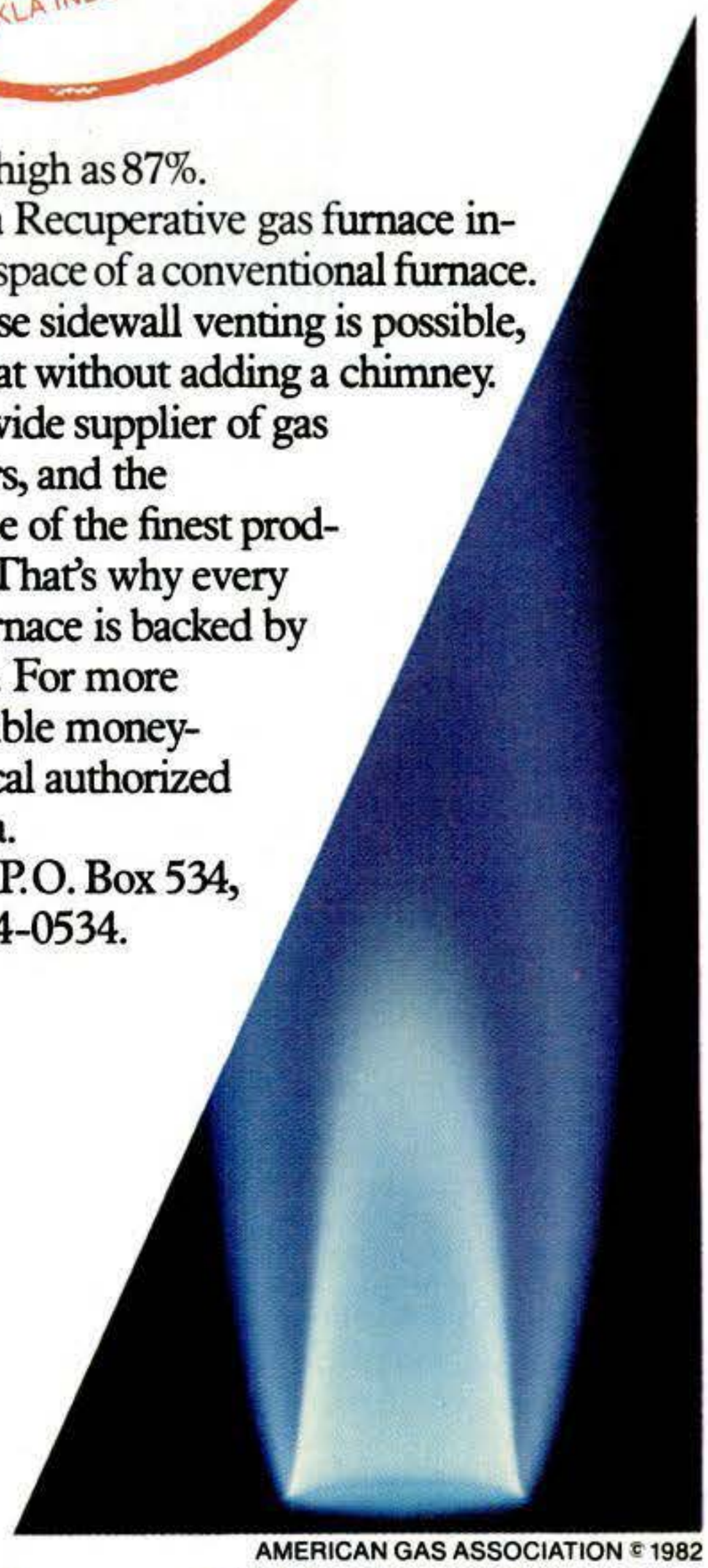

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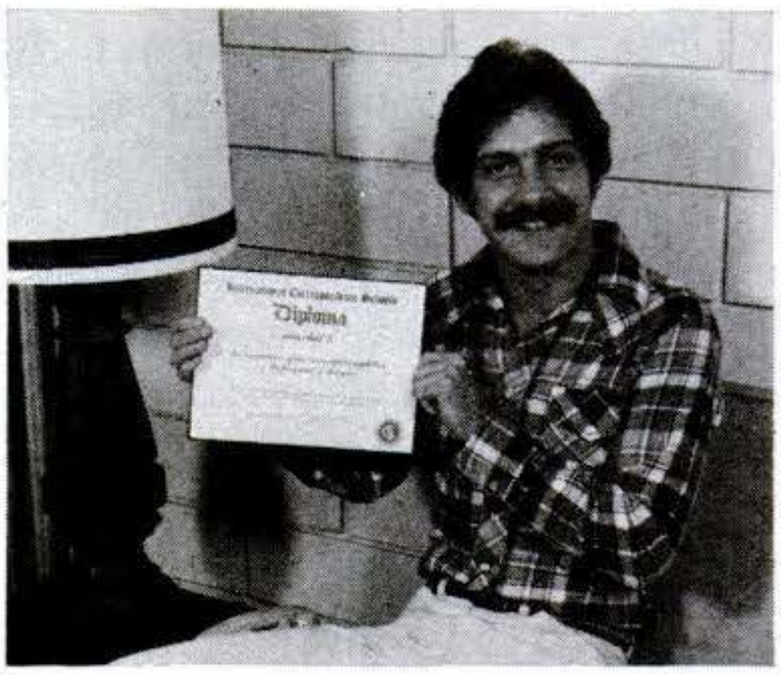

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Look and listen

[*Continued*]

capabilities. A scrambling technique enables subscriptions for up to 20 pay-movie or other categories in five four-channel banks (tiering). Parents can also lock out programs they don't want their children to watch.

Zenith's latest proposal, presented at a spring cable-TV conference, is for full-field teletext over cable. A full-field transmission would use the complete TV signal instead of blank TV lines that limit speed and capacity with current over-the-air systems. The technique could deliver as many as 500 pages (full screens) of information per second to choose from, says Zenith, which has hardware for the job.

Options ready this fall include something called Redi-Plug, which enables Z-TAC to accept add-on modules for two-way interactive services or other features. Another addition, called TAC-ALONG, lets TV operators add addressability to a non-addressable system.

Quick looks

- Panasonic, using a new solid-state chip for dbx companding (compression of audio signals before recording, expansion for playback), has introduced its $150 RQ-J20Z portable cassette player. The dbx encoding reduces tape noise by over 25 dB and greatly expands dynamic range. Dbx Inc. (Newton, Mass.) has launched a program of dbx-encoded cassettes with 50 recordings.
- Sony's Beta-format VCR's, which along with VHS decks have been plagued by poor audio fidelity due to slow tape speed, may change radically next year. The firm has demonstrated a technique of combining TV audio with the video signal for stereo recording. During playback, fidelity is said to exceed broadcast-FM standards and even approach the quality of digital audio.
- Are you violating federal law when you videotape copyrighted programs? A California judge, ruling against Sony and in favor of Universal City Studios and Walt Disney Productions, says yes. But the Supreme Court has agreed to hear the case for the final ruling on copyright legality. Film makers are seeking a tax on VCR's and blank tapes for royalty payments.
- If you insist on frequency response of two Hz to 20 kHz, flat within 0.5 dB, plus harmonic distortion of less than 0.01 percent in your audio tape recordings, you might look into Technics' new eight-lb. portable digital audio processor. With Technics' PV-5110 video recorder, the 18-lb. combo can put two hours of phenomenal audio on a single T120 VHS cassette.
- Canon and Pentax are marketing portable VCR's made by Matsushita and Hitachi, respectively. The Pentax $1,270 deck is matched with a $1,070 4.2-pound TV camera. Canon's camera has an 11-to-70-mm f/1.4 zoom lens with macro focusing, plus a built-in character generator so you can title your productions while shooting. PS

A video cassette mechanism needs to be more than a package for your tape.

Your video cassette mechanism needs to do more than store and transport your video tape. Because a lot can go wrong with your picture that has nothing to do with your tape.

Our specially engineered cassette mechanism maintains proper tape tension, preventing jamming and snapped leaders so that your tape can have a longer life.

We also designed our mechanism for optimal tape-to-head contact to prevent skewing and jitters. And we use stainless steel pins to support the guide rollers which provide better alignment and tape-edge protection than the plastic pins used by some manufacturers.

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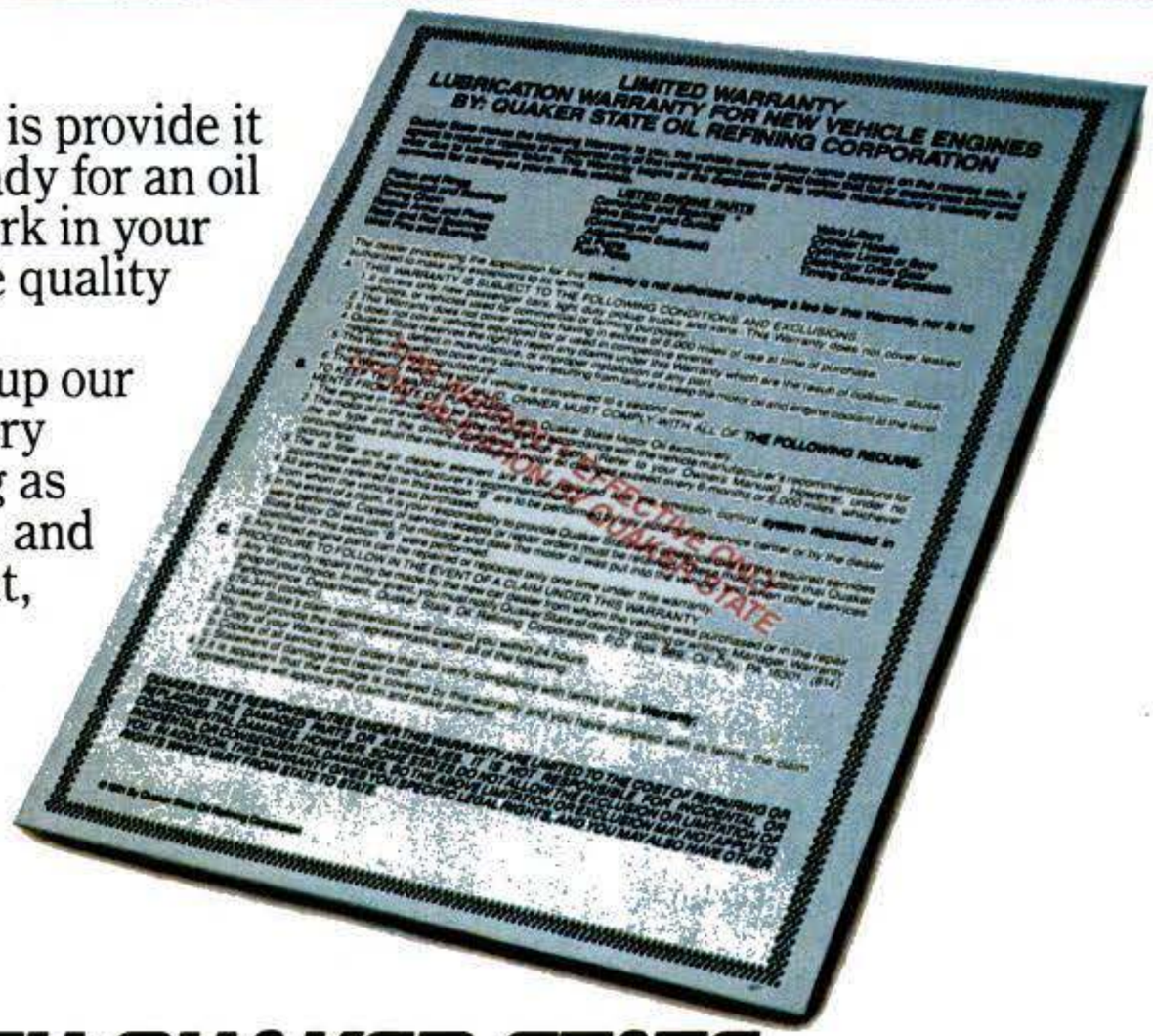
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PS car test & driving report

Sporty quartet
—fast, frisky, and fuel-efficient

By JIM DUNNE
PHOTOGRAPHS BY GREG SHARKO

Why does just about every major auto manufacturer include a sports car in its model lineup? They're not big sellers. And unlike their more sedate brother models, they're usually designed without consideration for either space or gas efficiency. Yet a company's lineup is apparently incomplete without the flair and spirited image of sporty models.

To find the answer, POPULAR SCIENCE tested four typical mid-price sports cars. Three are new for 1982: Renault Fuego, Toyota Celica Supra, and Volkswagen Scirocco; the other, Dodge Challenger, is a two-year-old design that's a sleeper, seldom getting the attention it deserves.

First, sports cars are more fun to drive than family sedans. You travel in style, inside a responsive chassis that will easily outrun and certainly outhandle 90 percent of the cars on the road. Sports-car ownership provides initiation into an elite group of discerning motorists.

In the PS acceleration test, the four sports cars exhibited expected quickness when moving from zero to 60 mph, but all were not as fast as muscle cars. It should be noted that mid-price sports cars are not primarily built for standing-start acceleration. Instead, they are designed to cut and dash quickly once up to speed. On that

Continued

PS ratings— test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	Renault Fuego	Dodge Challenger	Volkswagen Scirocco	Toyota Celica Supra
Acceleration	5	5	5	5
Braking	2	1	3	2
Handling	5	5	4	5
Maneuverability	5	5	4	5
Quietness	2	2	2	2
Roominess	2	3	2	2
Vision	5	5	5	5
Entry/exit ease	3	3	3	3
EPA economy	4	4	5	4
Ride comfort*	4	2	2	3

*Author's opinion

New generation of sports cars offers plenty of quiet comfort plus room for a family of four—along with surprising fuel economy. Cars (clockwise from bottom) are Toyota Supra, Dodge Challenger, Renault Fuego, and Volkswagen Scirocco.

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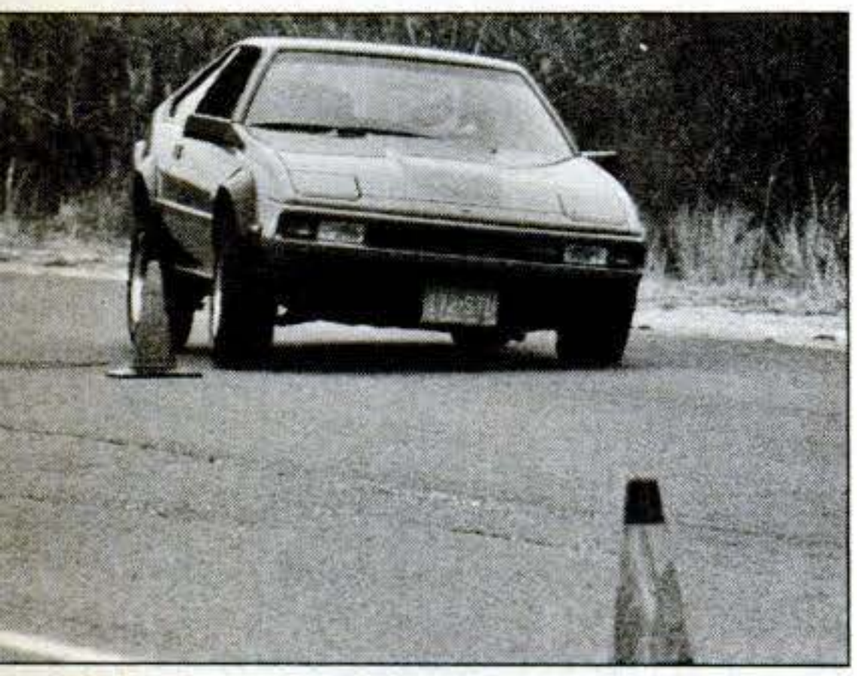
Fuego's body rolled heavily through the low-speed maneuverability test, yet steering inputs provided precise handling.

Despite the lifted wheel, Scirocco scored very good grades for the high-speed-handling section of the test.



Supra's muscular twin-cam in-line six hustled the car quickly through the cones to easily capture top honors in handling.

Challenger locked up its brakes and slid in the 60-mph panic stop. The car remained straight and within the lane, though.

score, the four delivered as intended.

A smooth-working gearbox with short, sure throws is another sports-car necessity, one that each maker of the cars in our test was careful to supply. In the Supra, both the five-speed manual and four-speed automatic were sampled, and you can't go wrong either way. The automatic has an overdrive fourth gear that can be locked out for better performance by flicking a switch on the shift console. The front-drive Scirocco and Fuego have the same snappy, sure-feel shift pattern as the rear-drive Challenger and Supra, with none of the previous front-drive shift-linkage sloppiness or engine-power feedback.

Sports-car builders go to extremes to make certain that the driving position is comfortable for operators of varying shapes and sizes. Each of the test cars had seats that were much more adjustable than those usually found in passenger sedans. The front buckets are sharply molded and contoured to hold pilot and co-pilot snugly in place.

Lean-back, rock-back, and up-and-down positions are also included, in addition to the standard fore-and-aft adjustment. After the seat is completely set up, you get the feeling you're "wearing" the car instead of just sitting in it.

Supra, in addition to other adjustments, has the most novel and effective lumbar-support system yet: It's inflatable. Compressed air—supplied by a squeeze bulb—gives the driver an infinite number of positions for lower-back support. The bulb projects out from the right side of the seat next to the hand brake, where it's especially easy to operate.

How do you like your sports car dressed up? There are choices. Supra is almost overdone, with a lighted-display tachometer that curves like the power curve of the engine. At the other extreme is Scirocco's Teutonic efficiency and simplicity, which leaves virtually nothing besides the speedometer and tach to divert the driver's attention. In between are the surprisingly complete instrumentation and outfitting of Challenger and the clean, uncluttered Gallic look of Fuego.

If there's one area in which all four cars fall short of expectations, it's braking. The hard, long-wearing tire compounds may be at fault here. Scirocco was best, but it scored no more than a 3 on the PS rating table, well below what you would expect. More attention should be paid to this critical performance area, which has been

EPA fuel mileage (mpg)

	Renault Fuego	Dodge Challenger	Volkswagen Scirocco	Toyota Celica Supra
Highway	36	36	41	32
City	24	24	28	21
California city	24	22	28	21

PS fuel-mileage tests
(steady-state mpg)

35 mph	35.2	36.2	43.9	25.8
55 mph	31.7	29.5	36.3	28.5*

*Automatic overdrive

showing a steady drop in efficiency throughout the new-car population.

You may pay more for a sports car initially. These cars range from $8,000 to $16,000. But that does not mean economy is completely out of the question. Scirocco could qualify as one of the top-economy cars on that count: Its EPA numbers of 28 mpg (city) and 41 on the highway were backed up by the PS steady-speed test of 43 mpg at 35 mph and 36 mpg at 55 mph. None of the other cars came close to those marks, but none was excessively thirsty, either (see fuel-mileage box).

Renault Fuego

This is the four-seater flagship of the AMC-Renault alliance. It's imported from France, along with all of the French characteristics, including a soft ride; a small, high-revving engine; and seats probably more comfortable than those in your front parlor. Fuego's handling is not compromised by its soft ride. The car leans over more than you might expect, but it tracks predictably and responds to the steering wheel with reassuring precision.

Rear-seat room is surprisingly adequate for average-size adults, with head room better than almost any other car of this type. But front-to-rear seating distance is cramped; rear-seat passengers will find their knees pushed into the front-seat backs.

The turbocharger on the small 1.6-liter Fuego engine is typical of newer turbos. Turbo noise—a turbine whine in older versions—is nonexistent. You get no sense of the turbo boost coming on, just a steady delivery of engine power throughout the power curve. There was enough power to consistently break the tires loose during the first-to-second shift, especially if the nose was not pointed straight down the track.

However, the smallish four spends a lot of time working at high rev's, typ-

[Text continued on page 46]

For specs and test results, turn page

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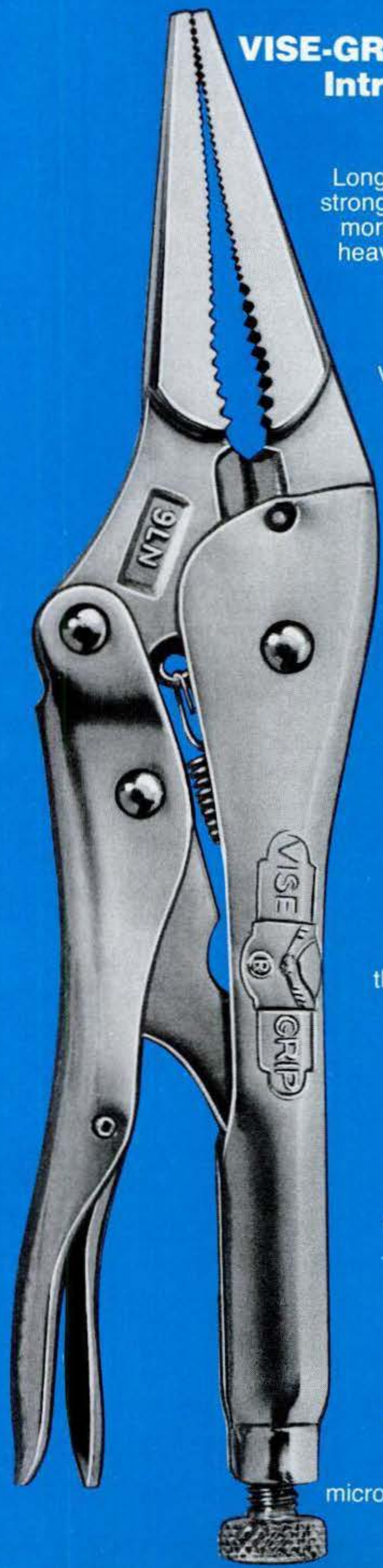
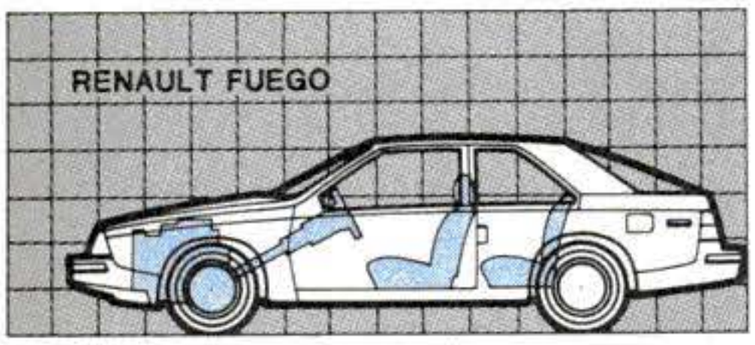
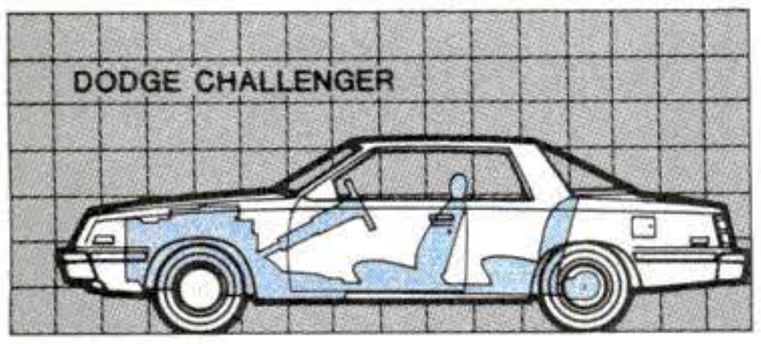
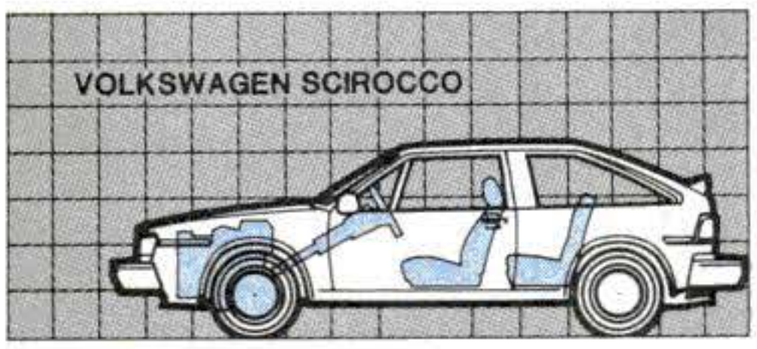


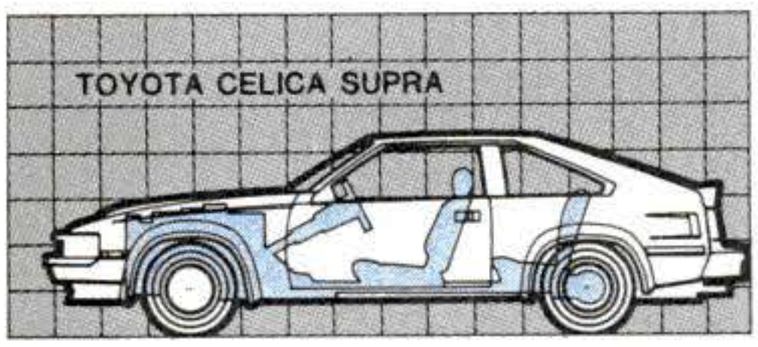
(Shown Actual Size)

Same easy release trigger and micro-adjustment screw.









ILLUSTRATIONS BY RUSSELL VON SAUERS

Contemporary mid-price sports cars are usually 2+2 setups, but rear-seat passengers will find very limited leg room and an uncomfortable lack of head room. At best, these seats are for young children.

PS serviceability ratings

How easy is it to service these cars? To give you an approximation of how difficult it is for a typical person to perform various service operations, we examine each test vehicle. The numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty; 4, easy; 5, very easy.

	Renault Fuego	Dodge Challenger	Volkswagen Scirocco	Toyota Celica Supra
Checking fluid levels				
Battery	3	4	5	5
Master cylinder	5	5	5	5
Windshield washer	5	5	5	5
Engine oil	5	5	5	5
Coolant	5	5	5	5
Checking the engine				
Spark plugs	5	4	5	4
Distributor	5	5	5	5
Carb adjustment	F.I.	4	F.I.	F.I.
Oil filter	n.a.	5	5	4
Oil fill	5	5	5	5
Replacing hoses				
Upper radiator hose	4	5	5	5
Lower radiator hose	3	4	4	3
Heater hoses	3	3	3	3
Changing bulbs				
Headlights	3	5	5	5
Taillights	2	5	5	5
Front running lights	3	4	4	5
Front parking lights	3	4	4	5
Front directionals	3	4	4	5
Rear directionals	2	5	5	5
Rear running lights	2	5	5	5
Checking fuses	2	5	5	5
Spare-tire accessibility	3	3	3	3
Changing belts	2	5	4	3

Renault Fuego, Dodge Challenger, Volkswagen Scirocco, and Toyota Celica Supra —dimensions, specs, and test results

	Renault Fuego	Dodge Challenger	Volkswagen Scirocco	Toyota Celica Supra
DIMENSIONS (inches)				
Wheelbase	96.1	99.7	94.5	103
Overall length	176.8	180	165.7	183.5
Overall height	50.5	52.8	51.4	52
Overall width	66.6	66	64	66.3
Track, F/R	56.4/53	54.1/53.4	54.7/53.5	56.3/55.1
Ground clearance	7	7.5	7	7.25
Front head room	36	34	35	35.5
Front hip room	44	40	40	40
Front leg room	44	44	43	45
Rear head room	33	35	33	33
Rear hip room	47.5	47.5	49.5	45.5
Rear leg room (min.)	31	36	31	31
Rear knee room (min.)	−1.5	2	−1	1
Couple distance	25.5	28	27	27
SPECIFICATIONS				
Engine type	In-line 4	In-line 4	OHC in-line 4	Twin-cam in-line 6
Displacement (cu. in./L)	95.5/1.6	156/2.55	105/1.7	168.4/2.8
Compression ratio	8.6:1	8.2:1	8.2:1	8.8:1
Carburetion	F.I.	2 bbl.	F.I.	F.I.
Net hp @ rpm	107 @ 5,500	100 @ 5,000	74 @ 5,000	145 @ 5,200
Net torque @ rpm	120 @ 2,500	137 @ 2,500	90 @ 3,000	155 @ 4,400
Transmission	5-speed manual	5-speed manual	5-speed manual	4-speed automatic
Axle ratio	4.12:1	3.308:1	3.89:1	4.1
Tire make	Michelin	B.F. Goodrich	Michelin	Dunlop
Tire type	TRX radial	Radial	XZX radial	SP Sport 03 radial
Tire size	P165/70HR14	P195/70R14	P175/70SR13	P225/60HR14
Steering	Power, variable rack and pinion	Power, recirculating ball	Manual, rack and pinion	Power, variable rack and pinion
Overall steering ratio	16:1	18.6:1	20.8:1	18:1
Turns, lock to lock	2.8	4	3.9	3.2
Turn diameter (ft.)	33.9	36.2	31.2	36.7
Front suspension	Independent w/lower A arms, upper transverse arms, coil springs	Independent, strut-type coil springs	Independent, MacPherson struts, coil springs	Independent, MacPherson struts, coil springs
Rear suspension	One-piece box-section rear axle, central A-shaped control arm	Rigid axle, upper and lower control arms, coil springs	Independent, stabilizer axle, coil springs	Independent, semi-trailing arms, coil springs
Front stabilizer-bar diameter (in.)	0.75	0.86	None	0.98
Rear stabilizer-bar diameter (in.)	Tube type, 0.99	None	None	0.51
Trailer towing (max. lbs.)	998	1,325	No recommendation	1,000
Trailer tongue weight (max. lbs.)	110	245	No recommendation	100
Brakes	Power with rear proportioning valve, disc/drum	Power, disc/disc	Power, disc/drum	Power, disc/disc
Brake swept area (sq. in.)	n.a.	350.1	n.a.	367
Fuel tank (gal.)	14.8	15.8	10.6	16.1
Trunk space (cu. ft.)	13.76	9.27	23.7*	20.8*
Liftover height (in.)	36	33	31	30
Curb weight (lbs.)	2,379	2,767	2,060	2,800
F/R weight distribution (%)	59/41	53/47	n.a.	55/45
Basic price	$8,494	$8,043	$10,150	$14,098
Price as tested	$10,704	$9,624	$10,965	$16,100
Major options (over $100) on test car	Turbo package $1,000, TRX tires $425, A/C $620, visibility option $135, AM/FM cassette $129	A/C $620, AM/FM stereo $197, cruise control $138, wheel package $382	Rear wiper $125, A/C $690	Leather seats $430, sun roof $440, paint $120, AM/FM stereo $420, digital instruments $450
TEST RESULTS				
Acceleration (sec.) 0–60 mph	11.5	12.8	14	11
Brake test (cool) 60–0 mph				
Stopping distance (ft.)	169	171	157	167
Pedal pressure (lbs.)	80	124	55	120
Brake test (hot) 60–0 mph				
Stopping distance (ft.)	174	197	150	172
Pedal pressure (lbs.)	80	118	62	180
Interior noise @ 60 mph (dBA)	71	71	70	71
Handling test (mph)	65	65	62.5	66.5
Maneuverability test (mph)	27.4	29.3	27.1	28.5

TEST CONDITIONS: Ambient temperature, 60°F; relative humidity, 65 percent; barometric pressure, 29.7 inches Hg
*With rear seat folded

Performance comparison with selected 1982 models

	Mpg (city driving)	Acceleration 0–60 mph (sec.)	Brakes 60–0 mph (hot) (ft.)	Handling (mph)	Maneuverability (mph)	Noise @ 60 mph (dBA)
1982 Ford Mustang V8	18	9.7	153	59.5	27.4	73
1982 Pontiac Firebird V8	17	10.1	188	64.7	28.1	69
1982 Corvette V8	14	8.4	184	59.5	27.6+	74
1982 Datsun 280-ZX Turbo 6	21	9.8	148	65	27.6+	73
1982 Mazda RX-7 Rotary	21	11.8	209	65	27.6+	75
1982 Porsche 924 Turbo 4	20	9.5	150	65	27.6+	74

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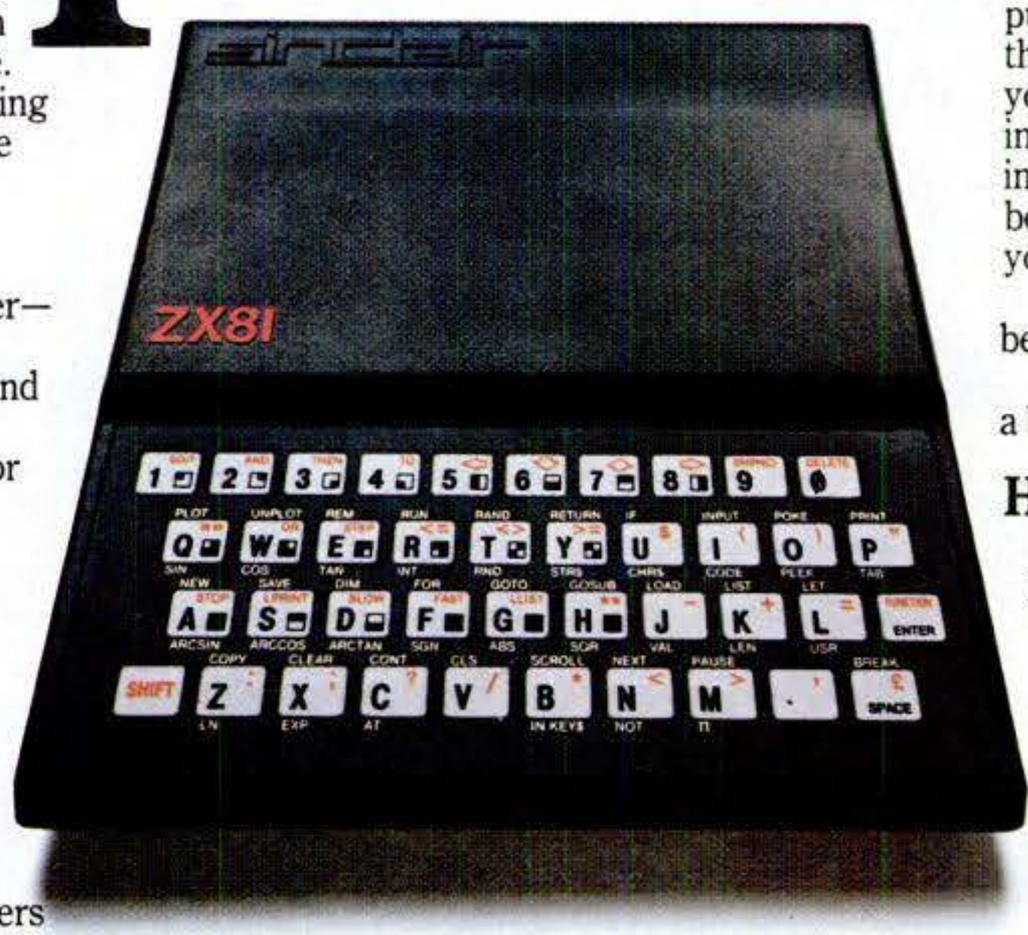

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A reenactment of Ford Ranger winning the San Felipe 250.

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ical of the design of Renault power trains. Is the engine too small? Apparently not. Fuego is quicker than Scirocco and Challenger in zero-to-60-mph acceleration and still delivers adequate fuel economy for its class.

Dodge Challenger

This sporty version of the Dodge Colt, made by Mitsubishi, is one of the leaders in offering extra equipment for driver comfort and convenience. The seat is one example. It rocks, lies back, and has an adjustable lumbar support. For the front passenger, a memory device returns the seat to the original setting after it slides forward when rear-seat passengers board or exit. Another good idea is the storage tray under each front seat: It holds odds and ends that usually clutter a glove box or console tray.

As in Fuego, rear-seat room is surprising if not spacious. Two adults can ride with reasonable comfort. Head and knee room are no problem. Still, the interior feels confining, with much less room than you get in sedans or bigger sporty cars.

Trunk space doesn't appear to be much of a problem either, because of the regular, usable shape of its interior. However, Challenger does have the smallest trunk in the group. Furthermore, it doesn't have the hatch arrangement that would expand the cargo capacity to a more acceptable size.

It's interesting to note that the high-economy engine has enough spunk to beat Scirocco in zero-to-60-mph acceleration, though Challenger is still a notch behind Fuego and Supra in this important performance feature.

Volkswagen Scirocco

If you appreciate simplicity along with a highly responsive chassis, Scirocco is the best bet in this lineup. The car is agile and steers with precision. It's the kind of car that would please early-sports-car buyers, providing bare-bones fun like an MG-TD with some added comfort and additional luggage capacity. Opening the rear hatch reveals a surprisingly large, flat stowage area. And, of course, the seats fold forward for additional room if necessary.

Interior trim is simple and straightforward at the risk of being stark. But everything you need for pure driving efficiency is there—quick manual steering, easy shifting with short throws between gear positions, a five-speed overdrive transmission with ta-

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chometer, and sharply molded front seats. As with Challenger, excess room has been pared away so you are left with only the essentials.

One questionable nonessential is rear-seat room. The average adult passenger will find barely enough room. Head clearance is the biggest problem. Adults can use the rear in an emergency for short trips, but it's really only suited to children.

Although each of the sport cars will impress you with a relatively quiet ride, Scirocco, with only low-frequency sound from the engine and gearbox, is the quietest of the quartet. Interestingly, all four registered noise levels well below those in sports cars of five years ago. This group now ranks on a level with compact sedans when road and wind noise are measured from inside the passenger compartment.

Toyota Celica Supra

If engineering overkill were a felony, Supra would be a rolling crime wave. On the outside is a balanced styling blend of Camaro muscle with 280-ZX luxury, and the inside is even more impressive. You get an overdose of high-tech extras, including push-button overdrive, graphic tachometer curve, and the most complicated radio controls this side of the space shuttle Columbia. Add to those the digital speedometer and you have an instrument panel that ranks with the most fascinating on the road.

The sophisticated twin-overhead-cam, 2.8-liter, six-cylinder engine is one of the most advanced power plants being offered in a mass-produced automobile this year.

The suspension is a four-wheel independent type with disc brakes at all corners. This enables Supra to deliver a pretty fair ride while still providing the aggressive handling that's mandatory for this type of car.

Front-seat room and comfort are outstanding, even for a sports car. The sharply contoured front seats look and feel more luxurious than the competition's, and the driver's seat has three adjustments for position in addition to the inflatable lumbar support.

Author's choice

Supra offers too many goodies to resist, even though its price tag is inflationary for most pocketbooks and fuel economy is the worst of the lot. If you want a car for the fast lane, there are few better equipped. And though the instrument-panel gimmickry may be overdone, it's a great diversion for breaking up boredom on long trips. PS

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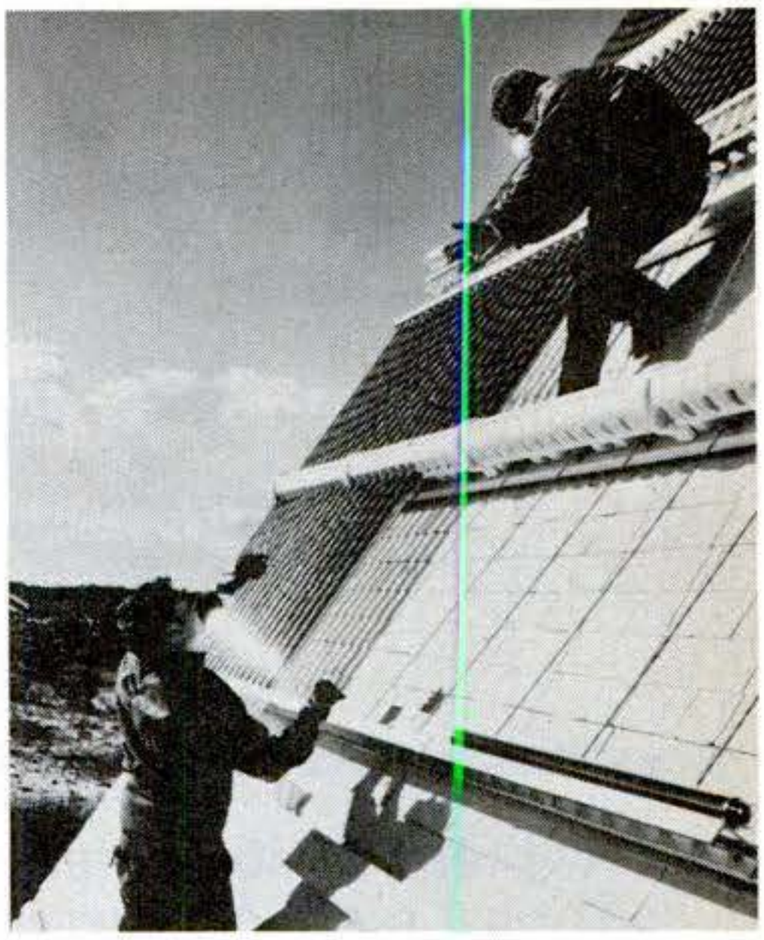

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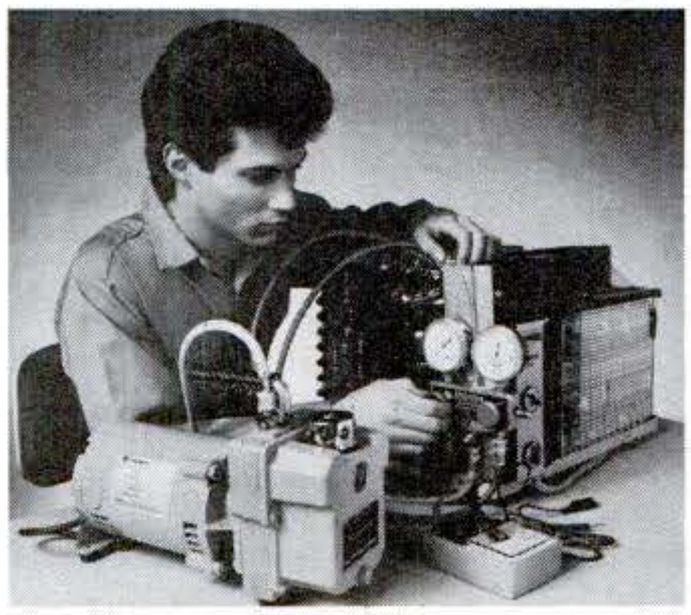

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Expert systems
—computers that think like people

A new breed of computer vaults past mere number-crunching to something akin to human thought

By EDWARD EDELSON

After considering a long list of signs and symptoms, the consultant was closing in on a diagnosis of the patient's unusual lung disease. It looked like an infection caused by a bacterium named Nocardia, but a few more questions were needed to clinch the diagnosis.

"Skin draining sinus?" asked the consultant.

"No," was the answer from the primary physician, Dr. John D. Myers of the University of Pittsburgh.

"Fever intermittent?" Again, no.

"Acid-fast bacteria by stain?" Yes.

"Nocardia by stain?" Yes.

"Culture Nocardia?" Yes.

"Conclude Nocardia," said the consultant.

The dialogue was stilted—but then, you don't really expect flowing prose from a computer program. Dr. Myers was on the 13th floor of the University of Pittsburgh's Scaife Hall. His "consultant," a program named Caduceus, was in the memory of a computer 2,500 miles away at Stanford University in California. I was being given a trial run to show how Caduceus will someday help doctors make difficult diagnoses.

Caduceus is the most complex example of a new breed of computer programs called expert systems. They're programs that are supposed to take over some of the thinking tasks now done by human experts—designing computer systems, analyzing mineral deposits, determining the molecular structure of unknown chemicals, even writing parts of computer programs.

The best way to describe the difference between an expert system and the sort of computer program that your bank now uses to prepare your monthly statement is to think of them as people.

Today's computer program is an idiot savant that has only two virtues: It follows instructions unerringly and it does arithmetic at blinding speed. That's great if all you want to do is process a lot of data quickly, but it doesn't make for evenings of sparkling conversation.

An expert system, by contrast, is a pipe-puffing savant with deep experience in a field of human knowledge. It can size up a situation and draw on a lifetime of experience to make reasoned judgments about the best course of action. It is not locked into a standard, rigidly prescribed, step-by-step problem-solving program—the typical computer algorithm. It can juggle various possibilities, deciding which best fit the situation, and pick the most appropriate route to a solution. Ask an expert system to explain a decision, and it will outline the reasoning that led to its choice.

> "If the computer can't get it or asks strange questions, it raises a red flag. We catch some awful bloomers"

Dr. Myers' program, for example, was considering four or five different diseases that fit the initial description of the patient. Every question it asked was designed to zero in on one or another diagnosis. Periodically the program would list the diagnoses that were still open and the facts that supported those diagnoses. For practical purposes, it was like having a distinguished consultant on the case.

In other words, an expert system handles ideas in the same way that humans do. In fact, it contains human wisdom, in a codified form. An expert system has two basic parts: a data base, the collection of information that experts in a field use to make their decisions; and an "inference engine," the set of rules that the experts apply to the information. To build an expert system, someone sits down with experts in a subject—for Caduceus it's internal medicine—and gets them to explain both the information and the rules that guide their judgments. The rules and the data, put into computer language, are the expert system.

Expert systems have been kicking around research laboratories for a decade or so, but now they're breaking out into the real world. A couple of expert systems—one to design computer configurations, one to diagnose lung diseases—are now in everyday use. Many more are in the planning or development stage. Such industrial giants as IBM, Texas Instruments, and Schlumberger are jumping into the field. And companies with names like Teknowledge, IntelliGenetics, and Machine Intelligence are springing up along Route 128 in Massachusetts and in California's Silicon Valley, near Stanford.

But if you're worried about an expert system bleeping into your office

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to take over your job tomorrow, there's no need to panic. For a variety of reasons, ranging from a shortage of trained personnel to the difficulty of choosing the right jobs to be computerized, it's going to take quite a while for most expert systems to be cranked up.

Perhaps most comforting, you don't have to worry about a relentless computer-contained brain that can outreason any human being in any thinking job. That image did exist in the early years of the discipline called artificial intelligence, which gave birth to expert systems. But after years of trying, workers in the field concluded that you can't give a computer a few general rules and expect it to deduce the real world in all its complexity. Instead, a computer program can do thinking tasks only if it contains all the detailed knowledge needed for a specific task (which is why some people prefer to call them "knowledge-based systems"). The key fact here is that all the knowledge has to come from human experts.

Expert systems do have some potential advantages over human specialists. They allow you to put the collected wisdom of a bunch of experts into one neat computer package. That can be invaluable when there are only a few experts available, as is true of the drilling data that Schlumberger processes. And a computer program's attention never wanders because it's tired or has a hangover. It can be a lot more thorough than a human expert. The human mind can weigh only seven possibilities at any one time, it's said, but a computer program can consider several hundred.

On the other hand, a computer program can't do anything more than human experts can accomplish. For example, Lee Hecht, president of Teknowledge, an expert-systems company in Palo Alto, Calif., told me that a knowledge-based program offers no particular help in managing a stock portfolio. "It's not clear that anyone can successfully pick stocks over the long run," Hecht explained.

And because they rely on human knowledge, expert systems aren't infallible. Expert systems can make the same mistakes as the humans who provided the information—plus a few that go with any computer program.

I saw both sides of the coin when I visited Dr. Myers' laboratory in Pittsburgh. When I walked in, Caduceus was taking part of the test that the National Board of Medical Examiners gives to all medical-school graduates. The computer program had been given the description of a case and was asking a series of questions to make the diagnosis, just as the aspiring doctors would do.

"If the computer can't get it or asks strange questions, it raises a red flag," Dr. Myers explained. "We catch some awful bloomers."

For example, a self-assessment test prepared by the American College of Surgeons included one question on a patient with thyroid disease. Any doctor would feel the hardness of the thyroid, an indication of scarring. But when Dr. Myers ran the question past Caduceus, he found that "the author hadn't put in anything about the consistency of the thyroid." The information was added before the test went out.

Score one for the computer. But a few minutes later, Dr. Myers was complaining that the list of signs and symptoms that allows Caduceus to make a diagnosis has to be exquisitely complete. "It's important to make it complete because if you don't put it on the list, the stupid machine says it doesn't belong," he said.

Dr. Myers, who has worked on the program for a decade with computer expert Harry E. Pople Jr., says the long-term plan is to have the program diagnose every one of the 700-odd diseases in the field of internal medicine. Right now, Caduceus has data on about 550 diseases. New ones are being entered slowly, Dr. Myers said, because "every time you put in a new disease and new manifestations, you have to be sure that the machine understands." Caduceus may go on line "in three or four years," he said.

About a mile down the road, at Carnegie-Mellon University, I heard about an in-operation expert system from its developer, John McDermott. The program, called simply R1, has been used since January 1980 to design computer systems sold by Digital Equipment Corp. (DEC), a job that once required human computer engineers.

Like all expert systems, R1 consists of two parts. One is a set of rules, which uses a general "if . . . then" principle. Humans use such rules constantly. When you start across the street, for example, you reason: "If a car is coming, then I'd better not go until it passes." In designing a computer system, an oversimplified rule would be: "If you need a large memory, then use component *X* rather than component *Y*."

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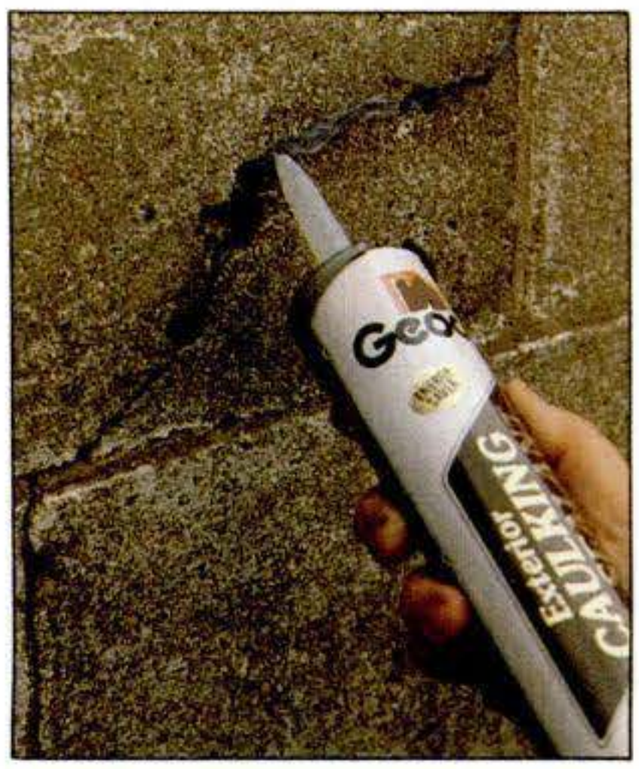

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Expert systems

[Continued]

The other part of an expert system is something that's often called an "inference structure"—a set of principles that guides the user from one rule to another as questions are asked and answered. Both the "if . . . then" rules and the underlying inference structure are assembled by interviewing human experts painstakingly to find out how and why they make their decisions. The interviews are done by people called—don't grit your teeth—"knowledge engineers."

At the start, McDermott was his own knowledge engineer. He got the first 250-rule version of R1 in a four-month series of interviews with DEC experts. When it was tried out, the first version had so many holes in it that a five-month expansion to 750 rules was needed to put it on line. R1 is now in its fourth version, with about 1,200 rules. McDermott has turned it over to a dozen or so DEC people who are constantly refining and changing the program to keep up with new developments.

> "Probably only 50 to 100 people in the U.S. have the right training for expert-system interviewing"

Now DEC is working on XSEL, a spinoff of R1 that will allow a computer salesman to sit down at a terminal and give a potential customer a list of components needed for a specific system. Another spinoff is a smaller program called ISA—Intelligent Scheduling Assistant—that determines the appropriate delivery date for a system. In the works is PTRANS, which will help in management of DEC's test and assembly plant.

If DEC is going great guns with these expert systems, why haven't other computer companies jumped in? One reason is that DEC is unusual. Most other computer companies specialize in off-the-shelf systems. DEC sells mostly custom systems that require choices among many different components. Another reason—which tells you something about the tricky nature of expert systems at this stage of the game—is that McDermott had a stroke of luck when he started the project. He could have tried to develop the program for DEC's established

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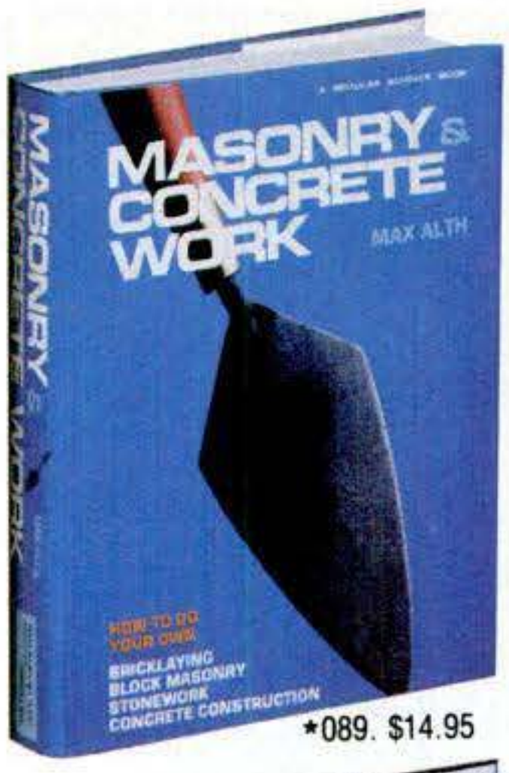

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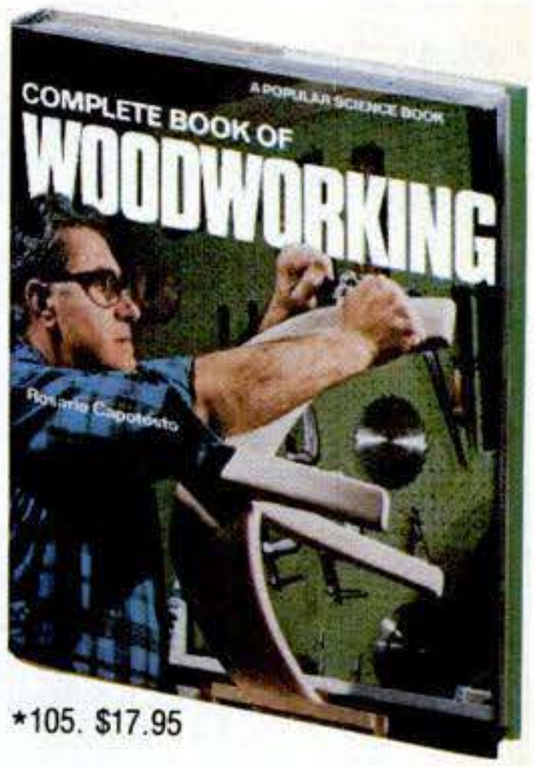

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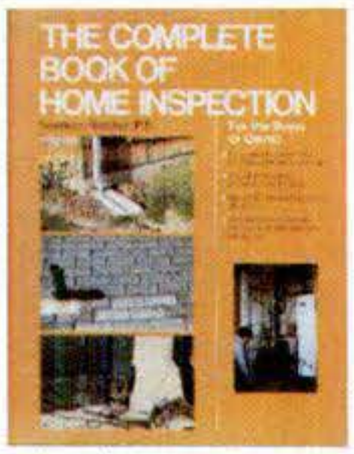

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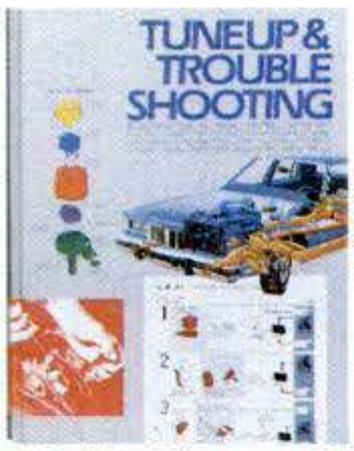

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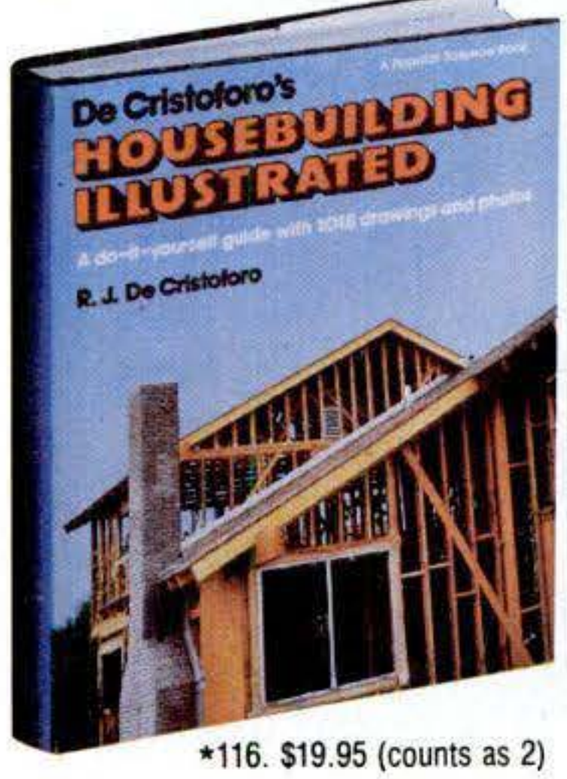

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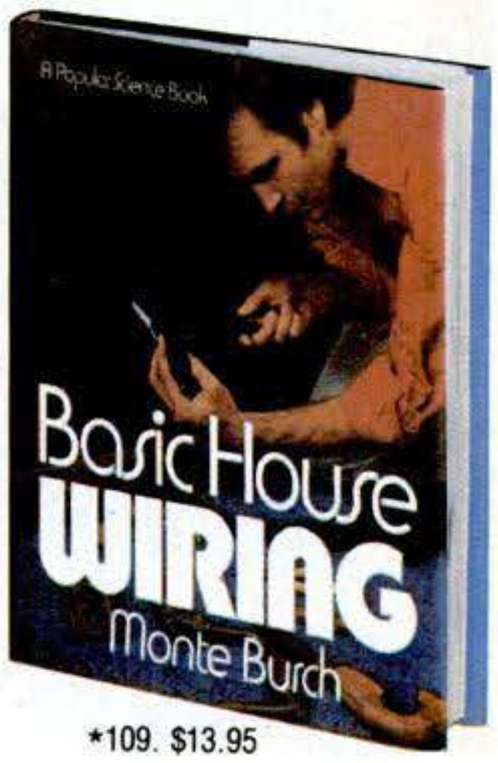

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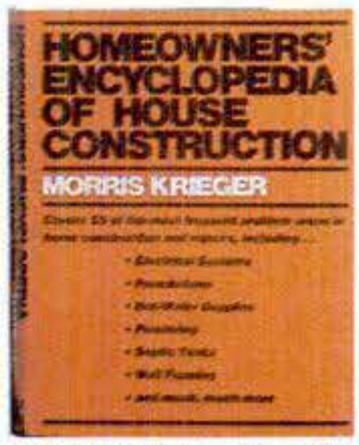

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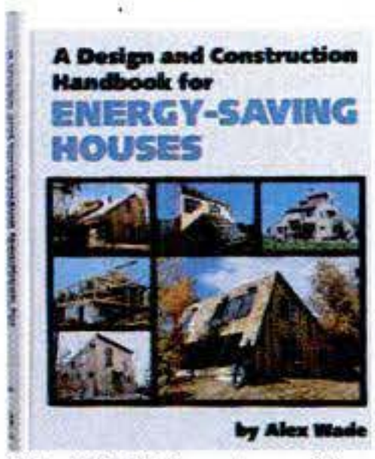

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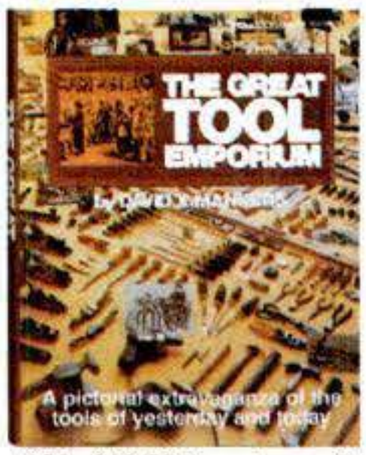

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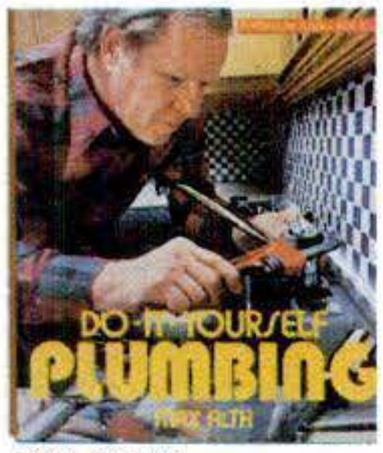

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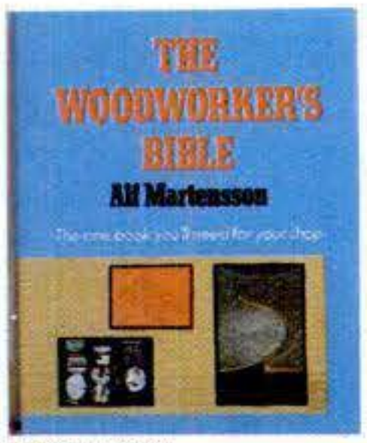

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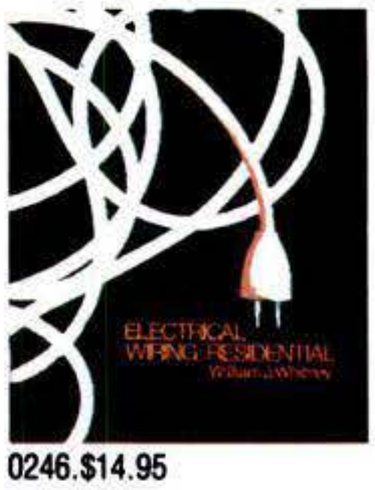

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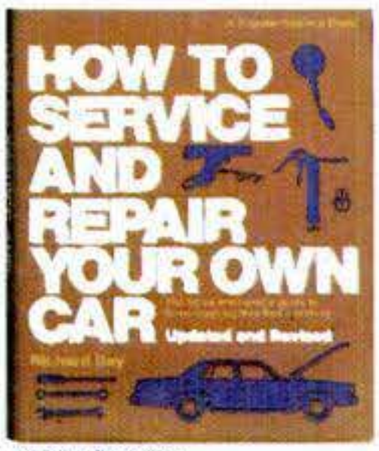

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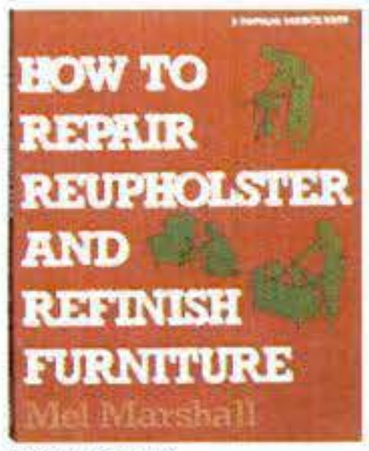

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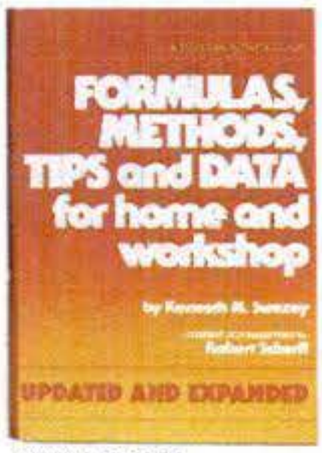

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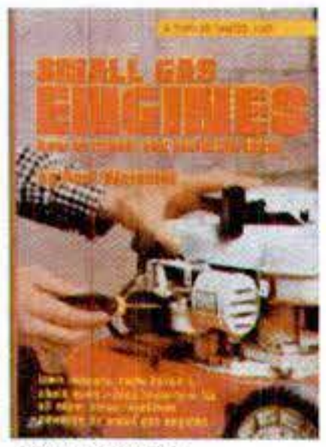

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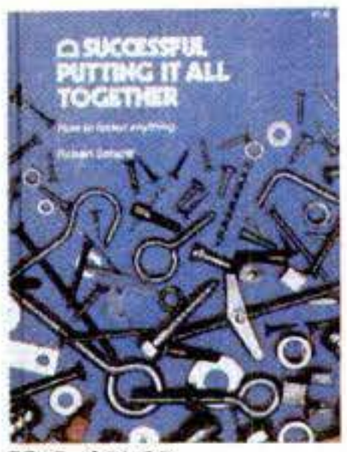

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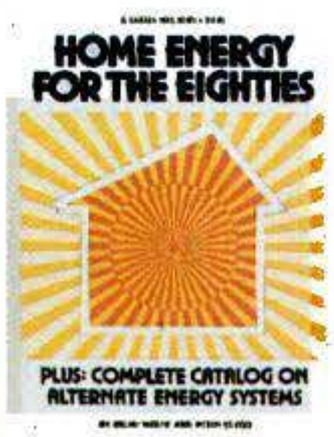

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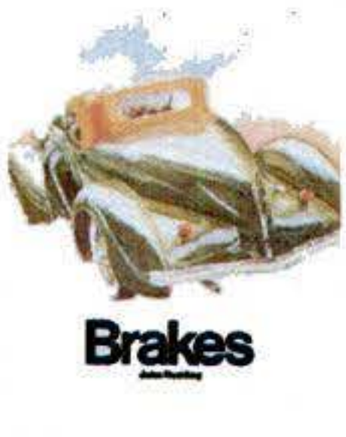

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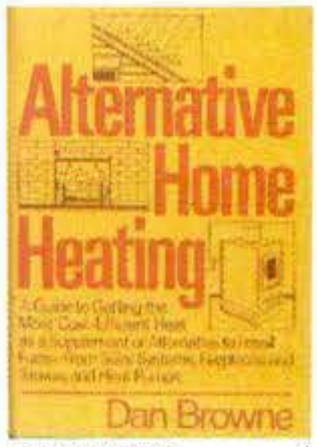

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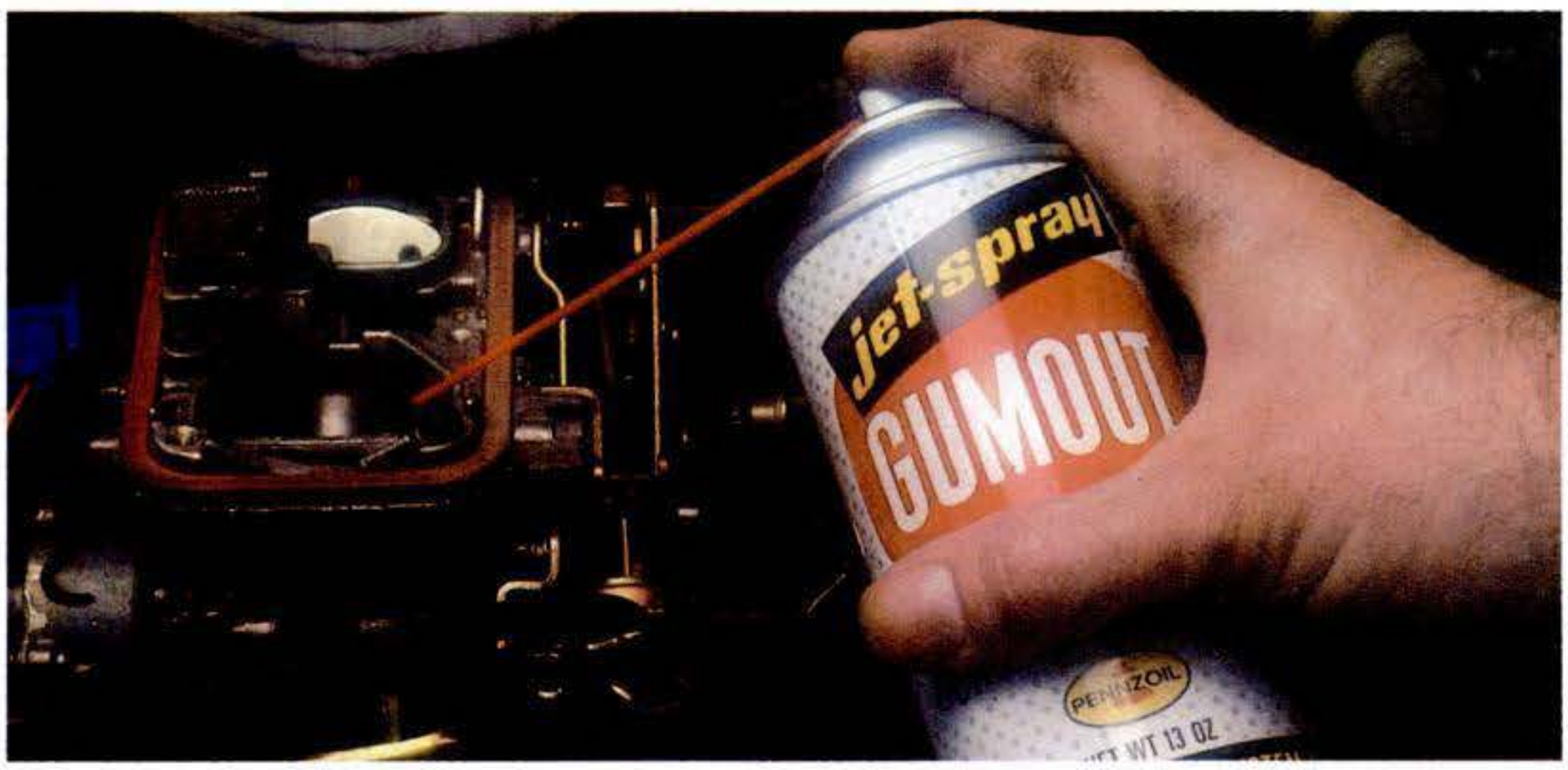

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Expert systems

[Continued]

PDP line of computers, which had about 10,000 components. In retrospect, McDermott says that the sheer size of the PDP line would have made the task imposingly difficult. Instead, he worked on DEC's new VAX line.

"At the time, the VAX had just been announced, so the number of components was relatively small—about 1,000," McDermott says. "That made it possible to collect the information that the program needed and to formulate the rules needed to configurate that particular set of components. The start-up cost of a program for the PDP would have been so high and the time needed to prepare the program would have been so long that the company might have gotten tired before I had any results."

John C. Kunz of Stanford University, who helped develop the only other expert system in everyday use, agrees that one key is to choose a problem of manageable size. His program is PUFF, which assists in diagnosing respiratory diseases at the Pacific Medical Center in San Francisco.

Kunz was the main interviewer, and almost all the data for PUFF came from one specialist, Dr. Robert Fallat. "He had the right personality characteristics," Kunz says. "He had an encyclopedic knowledge of the field and was introspective enough to understand how he reasoned. We did bring in other people to validate the data."

PUFF has been used on 2,500 patients over the last three years, says Richard R. Mitchell, associate director of Pacific Medical Center's Institute of Biomedical Engineering Sciences. Technicians feed data from a standard form into the computer, and PUFF gives a probable diagnosis.

"Something on the order of 90 percent of the time it's correct," Mitchell said. "The other 10 percent of the time it's incorrect because the program is incomplete. There's also a small fraction of the time that it's incorrect because bad data get past the technician."

An effort has begun to fill in an obvious gap in PUFF: The program doesn't include any mention of a patient's medical history, which can be a vital part of any diagnosis. "We've become damned good at asking questions to get the right information," Mitchell said.

There aren't that many people around who can ask the right questions, McDermott says. Expert-systems development needs "people who

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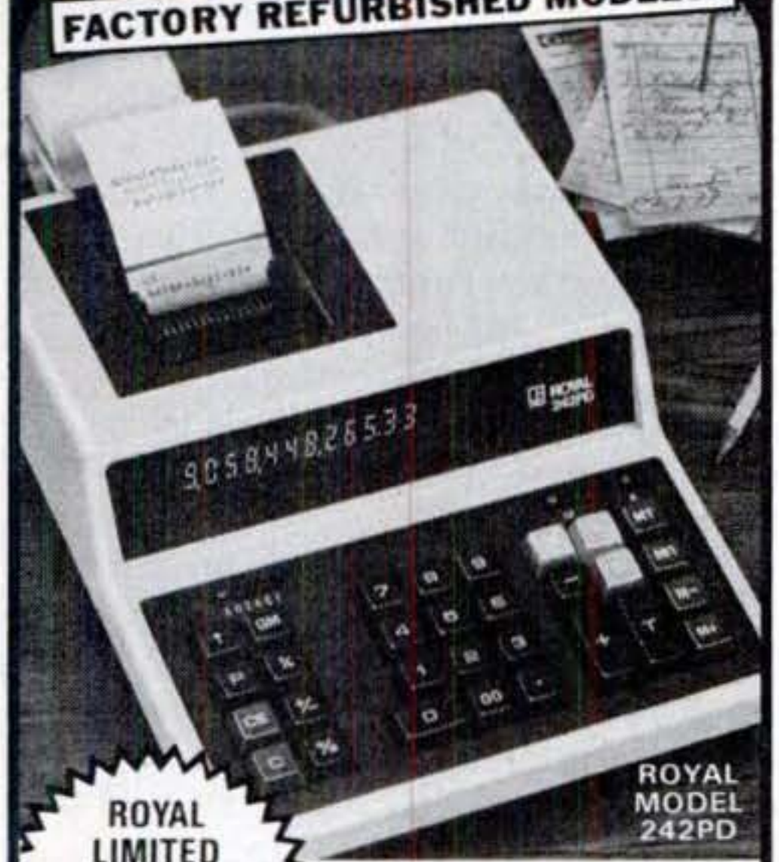

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are not only good at interviewing, but also know how that information is going to be represented. There are probably only 50 to 100 people in the United States who have training in this area right now. There's a tremendous gap between supply and possible demand."

Enter Teknowledge, Inc., which was founded last year by 20 members of Stanford University's artificial intelligence department. "We are the largest single center of expertise in the world," says Lee Hecht, who was brought in to manage the company. "Our founders have build more expert systems than anyone else."

Teknowledge's products include a set of training programs ranging from a one-day briefing for executives to a six-month course designed to turn out knowledge engineers. There have been inquiries from "more than 50 major companies from all over the world," Hecht says, and Teknowledge wrote $1 million in business in a two-month period early this year.

Teknowledge will also develop expert systems for specific applications. One example: a program that will assemble custom machine-tool assemblies from the components listed in a standard catalog. Another: a program that will help a major consumer packaging company cut waste from the present 10 percent level by developing uniform practices for small factories that are scattered across the country.

To preserve trade secrets, Hecht is cautious about mentioning specifics. But he does say that most programs won't come cheap. There's a limit to the speed at which knowledge engineers can work.

"The rule of thumb for any program containing more than 50 rules is that an interviewer can get one finished product rule out of one expert in one hour," he says.

A demonstration model of an expert system contains about 50 rules, Hecht says. A prototype has about 200 rules, and a full-fledged system, 500 rules or more. "Counting everything that's needed, you're talking from five to 20 man-years, a cost of perhaps $1 million to $4 million," he said. "But the payoffs can be mind-boggling. We estimate that the program for the packaging manufacturer could save $100 million annually by cutting waste in half. For an oil company, an expert system could save $1,000 per well per day. We're working on a prototype now."

Teknowledge is one of two companies that Stanford people have started. Just across the street in Palo Alto are the offices of IntelliGenetics. It is selling molecular-biology expert systems: GEL, which automatically manages the tricky job of determining sequences of nucleic acids, the raw material of genetic engineering; GENESIS, which allows scientists to run simulated cloning experiments; PEP, which analyzes and stores protein sequences; and so on.

A driving force behind both Teknowledge and IntelliGenetics is Edward A. Feigenbaum, one of the acknowledged giants of artificial intelligence. Knowledge engineering, Feigenbaum says, is edging toward a major growth spurt. "But we're still a cottage industry, getting gems of information out of experts' heads," he says.

Feigenbaum thinks the bottleneck will be broken when computer programs start doing the interviews—a view that he acknowledges to be highly controversial. Another problem to be overcome, he says, is gaining acceptance of expert systems in the world outside the artificial-intelligence community. Most potential users think of computers only as number-crunchers, Feigenbaum says.

> "We're starting to see companies where someone has the title 'manager of knowledge-based systems'"

The marketing of expert systems does seem to be in its infancy. For example, a computer program that writes parts of computer programs has been developed by Cordell Green and other experts at the Kestrel Institute, a nonprofit organization in Palo Alto. There are some common sequences to almost all complex computer programs, Green explains, and Kestrel's expert system helps a programmer write such a sequence in the most efficient way. "We've been able to write in two pages a program that took 10 pages otherwise," he said.

Kestrel's expert system could be a viable commercial product, Green says. (Kestrel can't market the program because it's a nonprofit institute.) So far no one has picked it up.

Then there's Prospector, a geological program developed at SRI International in Menlo Park, Calif., to help detect mineral deposits. Last year Prospector did identify a molybdenum deposit in the state of Washington. But Rene Reboh of SRI International says that no one has stepped forward to put Prospector to work on an everyday basis.

"SRI International is not in the business of selling software," Reboh said. "Our main function is to push technology as far as we can in the computer-science direction. We're now applying the same methods to hydrology to see if we can generalize the technique."

In medicine, no one knows for sure how doctors will accept the idea of a computer program as a consultant. John Myers says that doctors at the University of Pittsburgh who have used the program to help solve real-life problems "have been enthusiastic." But he adds that, sooner or later, he'll have to start tailoring the question-and-answer sequences so that Caduceus can talk fluently and politely to any doctor.

Richard Mitchell says that PUFF's success so far doesn't amount to a real test because it's been used primarily in a research setting with a limited number of doctors. He's encouraged by the history of computerized programs that interpret electrocardiograms. Once regarded with suspicion, the ECG programs now have been absorbed into routine medical practice.

Expert systems do seem to be passing the test of corporate acceptance. IBM is working with Stanford on a program to diagnose computer breakdowns. Schlumberger is working on a program to analyze oil-well logs (and has hired several people from SRI International). Other companies are developing their own in-house capabilities. "We're starting to see companies where someone has the title 'manager of knowledge-based systems,'" says Lee Hecht of Teknowledge.

And just to clinch it, the Japanese have become interested in expert systems, with a vengeance. Last January, the Japanese government announced that its program to develop "fifth-generation" computers—the hardware and software of the 1990's—will focus on artificial-intelligence applications. Ed Feigenbaum says that while the United States is firmly in the lead now, the Japanese have identified expert systems as the growth field of the future and are moving with their usual efficiency to dominate it. It will be a difficult challenge to meet. ■

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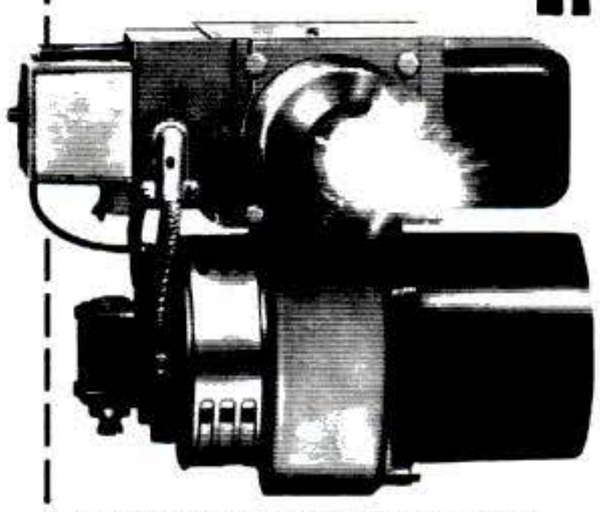

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RECREATION ROUNDUP

By HERBERT SHULDINER

Compact motor home

Are van conversions making a comeback? A new company, International Vehicles Corp., is betting they are. It has introduced this new Falcon "motor home" (photo above), which is actually a van conversion. It can sleep as many as six adults, and even offers galley and washroom. The Falcon comes on either a Dodge Maxi Van or Ford Supervan chassis and is only a little longer than a big station wagon. Because it's compact, the Falcon also handles like a wagon—not like a truck, as big motor homes do. There's a choice of three floor plans, all of which provide fully self-contained living comforts for camping trips. Engine for the Ford is a 302-cu.-in. V8, while the Dodge uses a 318-cu.-in. V8. The RV's are made by International Vehicles Corp., Box 424, Bristol, Ind. 46507. Price: about $20,000.

Snowless skiing

A 1,300-foot carpet made of a synthetic material from Wales is now installed at the Boston Hills Ski Area in North Andover, Mass., so skiers can do their thing without snow.

The synthetic surface is made of PVC filaments backed by stainless-steel stripping. The brushlike filaments are bonded together by wire to form mats that are placed on the slope in a fashion that makes an unbroken covering. The slope shown at left was made at Snowslope, north of London, England. The maker is Dendix Ski Slopes, Church St., Chepstow, Gwent, Wales.

New outdoor gear

Winnebago motor homes have become part of the landscape over the past couple of decades. Now Winnebago plans to extend its name to a broad range of outdoor gear and clothing. Among the products you should start seeing with the Winnebago name are camping stoves, heaters, lanterns, tents, and sleeping bags.

Light packs

High strength-to-weight ratio is designed into these new packs from Sierra West. Two of its newest models are the Cathedral (top photo, below) and the Half-Dome. The Cathedral pack is designed for

three-to-five day trips and costs $75. It has one vertical, external-entry rear pocket. Total volume is 2,000 cu. in.

The Half-Dome weighs only 27 ounces, but can carry up to 40 pounds of gear, the company claims. It's aimed at backpackers who require very light packs for long trips and has a removable back pad made of closed-cell foam and aluminum-wire mesh. Sierra West claims the pad adds stability to big loads and forms an internal frame that conforms to the wearer's back. The Half-Dome has three zippered pockets for extra carrying capacity and costs $99. Both are made by Sierra West, 6 E. Yanonali St., Santa Barbara, Calif.

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The final test of a motor oil comes under actual driving conditions. Havoline Supreme has proven it delivers the kind of protection needed in tough, high-speed state trooper cars and severe stop-and-go driving in New York City taxis.

Havoline helps save gasoline.

Fuel economy tests proved it. Compared to a conventional motor oil, Havoline

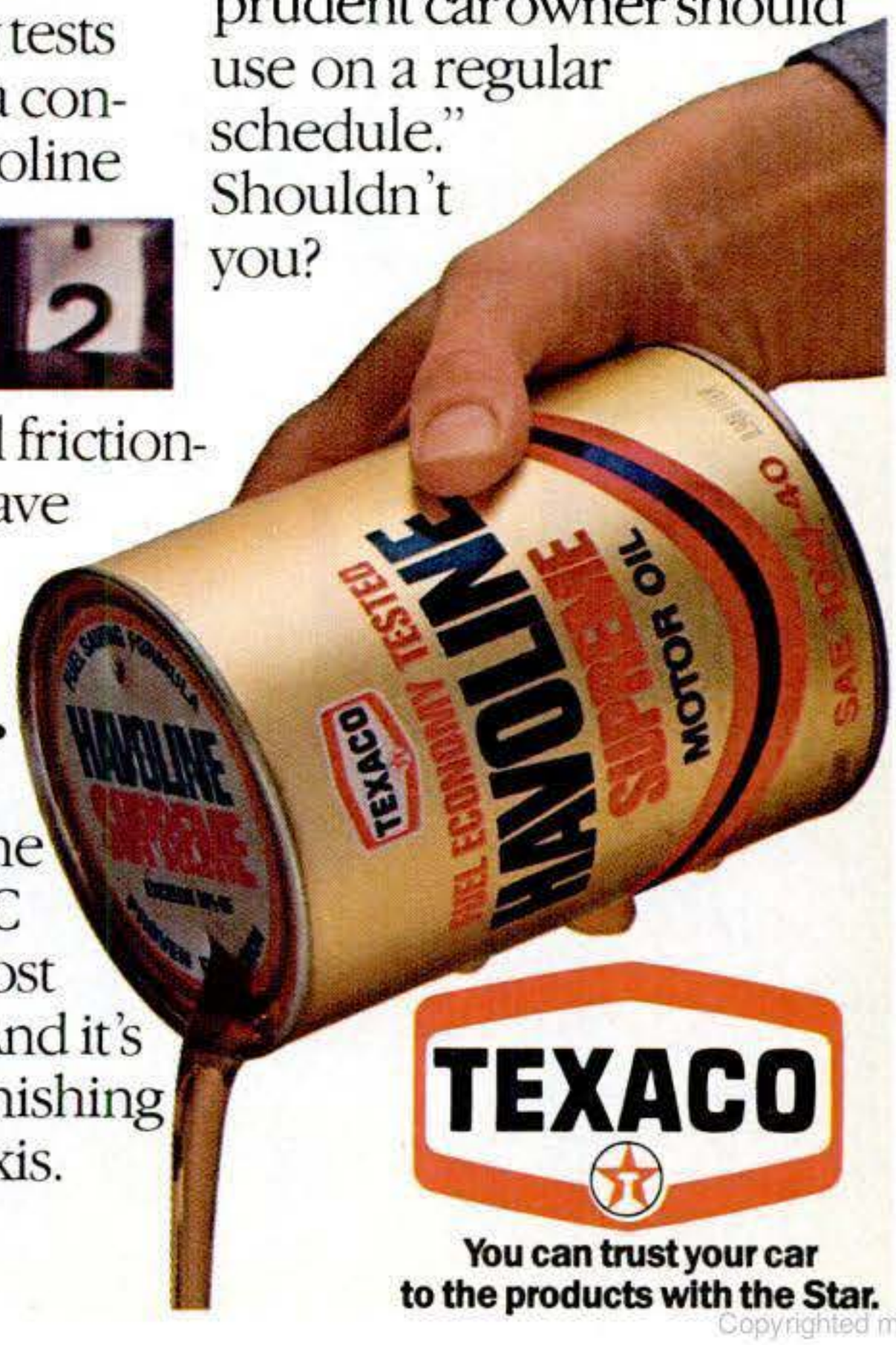
Supreme, with its special friction-fighting additive, helps save gasoline.

Havoline is diesel tested.

If you own a diesel, we have good news. Havoline 10W-30 has the API-SF/CC rating required by most engines like yours. And it's been proven in punishing diesel-powered taxis.

Listen to an expert.

Top Indy 500 driver Tom Sneva calls Havoline Supreme a "very sophisticated oil...one that a prudent car owner should use on a regular schedule." Shouldn't you?



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Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

16 mg "tar," 1.0 mg nicotineav. per cigarette, FTC Report Dec.'81

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Popular Science

PS | What's News

It will come as no surprise to regular readers of POPULAR SCIENCE, but a new report says that the electronic revolution you've been reading about in these pages is going to make drastic changes in the American home; transform business, manufacturing, and education; and totally revolutionize family and political life.

The report, done for the National Science Foundation by the Institute for the Future in Menlo Park, Calif., focused on a relatively narrow aspect of electronic technology: teletext and videotex [PS, Jan. '81]. Videotex is defined as a two-way communication system, teletext as one-way. When a substantial number of people have these relatively low-cost devices in their homes, the report says, it will be relatively simple to convert the home to a place of employment. Many of us simply manipulate information on the job, and it would be just as easy to do that in front of a terminal at home as in an office. There will also be a shift away from traditional schools to electronic education—which, again, can take place largely in the home. And finally, such systems can be used for shopping at home, banking, and so on. These machines will also make it possible to tap instantly into vast data banks, bringing, in effect, all of the world's information easily and quickly into the home. Such services as CompuServe and The Source [PS, Nov. '80] have begun supplying these services to their subscribers.

My only argument with the report is that its conclusions are probably too conservative. It also does not mention the fact that all of those teletext and videotex terminals that will be going into homes will start out as relatively dumb terminals; that is, they will contain relatively little in the way of computing power. But it doesn't have to be that way. The cost of microprocessors continues to go down, as does the cost of personal computers. There is no reason that home terminals can't be relatively powerful computers, as well as simply channels for sending and receiving information. The cost will be minimal. Thus we can look forward within the span of a relatively small number of years to the computerization of the American home. And that will have a powerful—and unpredictable—effect on our entire society and civilization.

Does that sound like an exaggeration? I don't think it is. Technology has a way of shaping our lives in ways we didn't plan. When the automobile came along, for example, it was perceived as just a substitute for the horse. But it has changed the face of the land, spawned the rise of the suburbs at the expense of downtown city areas, altered patterns of living and working. Television at first was perceived as strictly something that would be used for entertainment. But it is affecting the way children grow up and learn, it is changing cultural values, it may very well mean that pictures on the moving screen will eventually replace the written word as the prime means of conveying information. Profound cultural changes, indeed, that will alter our civilization in ways we cannot predict.

The computer will have a similar—perhaps even a greater—effect. With the beginning of the computer revolution—just now getting under way—it is possible for just about anyone to have as much computing power as he can use. Small, inexpensive computers now have all the computing power of the giant main-frame machines of two decades ago. And prices continue to come down.

The effects of this burgeoning computer revoution are bound to be significant. Right now, we're talking about people using their personal computers to balance their checkbooks, keep lists of recipes and the names and addresses of those to whom they send Christmas cards, and play games.

Is it really worth buying a computer to balance your checkbook and keep a few lists? Of course not. Then what can we use them for, and how will they affect our lives? I haven't the faintest idea and neither does anyone else. The Industrial Revolution gave people the ability to multiply the effects of their muscles. And we know that totally changed our civilization. The computer revolution will give people the ability to multiply the effects of their minds. I am absolutely certain they will find ways to use that incredible ability in ways nobody can predict. And our society, the way we live, work, play, and relate to each other, will undergo profound changes as a result. Now you see why I think the report was too conservative.

Super-computer

In the preceding item, I was talking primarily about the small, personal computer. But there is action on the other end of the spectrum, too. Back in June 1979 Jim Schefter reported on the Cray-1, the world's biggest and fastest computer, which cruises at 80 million calculations a second and in short bursts can reach the incredible speed of 250 million operations per second. Such massive computational power, of course, is useful primarily in crunching the numbers associated with scientific problems such as weather forecasting. Even big computers before Cray could take weeks to solve some of the more complex problems.

But that wasn't fast enough, and Cray has now introduced yet another supercomputer. It's the Cray 1S, and it is a startling five times as fast as the Cray 1. Speed isn't its only spectacular feature. The price tag will be between $11.4 and $14.5 million.

The shuttle goes up

When the space shuttle was originally planned, one of the main selling points was that payloads would be delivered to space for a fraction of the cost of doing the same job with throwaway rockets. Now it appears that expectations were too optimistic. When prices for launching space payloads for civilian customers were set in 1977, the cost of the entire cargo space for a launch was set at $18 million. Inflation has now driven this to $30 million, and it will rise to about $40 million over the next few years. But, say NASA officials, that won't be enough. Beginning in 1985, prices will more than double, to about $90 million per flight. In addition to inflation, two forces have shoved prices up. The first was that design and development cost more than anticipated. The other was the decision to cut back shuttle launches through 1992 from about 500 to something less than 300. So development costs have to be amortized over far fewer flights, which will add significantly to the cost of each launch.

Editor-in-Chief

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Low-cost, efficient **kit solar heaters**

Mount a Hansolar Solar Collector System in any of three ways: on a roof (top), on a wall (right), or through a window (above). The basic system includes two panels, mounting brackets, wall plates, connecting rings, thermostat, and a blower, for $495. Additional panels cost $179 each. You supply the four-in.-dia. PVC pipe or flexible dryer-vent hose that connects the panels to the house. The Window Manifold Kit, which fits double-hung windows up to 36 in. wide and includes a security window lock, costs $70. You can paint the manifold and connecting hoses black to match the collectors, or match them to your house.

You can start with two modular panels and add on later for more heat

By ERIK H. ARCTANDER

When Henry Ford brought out his mass-produced Model T in 1913 for $500, some 200 other auto makers were selling hand-built cars for over $2,000.

Jack Hanson sees a parallel between what happened to automobiles in 1913 and what's happening to solar heaters in 1982. His mass-produced system has a $495 price tag while conventional ones start at well over $2,000.

Hanson, 39, is a self-educated aircraft and missile designer, solar architect, and inventor who likes to "improve on things."

"In 1978," Hanson recalls, "my wife said we really had to do something about the fuel bills. Our old 7,000-sq.-ft. building was eating us up. My wife suggested I try solar collectors, but I told her it wouldn't be cost-effective unless I could double the heat output and quarter the usual collector cost.

"I decided to experiment anyway, since I had a leaky roof that I could cover with a collector instead of repairing. The collector was 75 ft. by 16 ft., and my calculations predicted a 25 percent fuel saving. But when we went over the bills later, we found the saving had actually been 65 percent," Hanson enthused.

That started him on a three-step development program. First, Hanson says, he improved heat output by a factor of five—making every square foot of collector area heat five cubic feet of air. This allowed him to shrink the collector to one-fifth its original size.

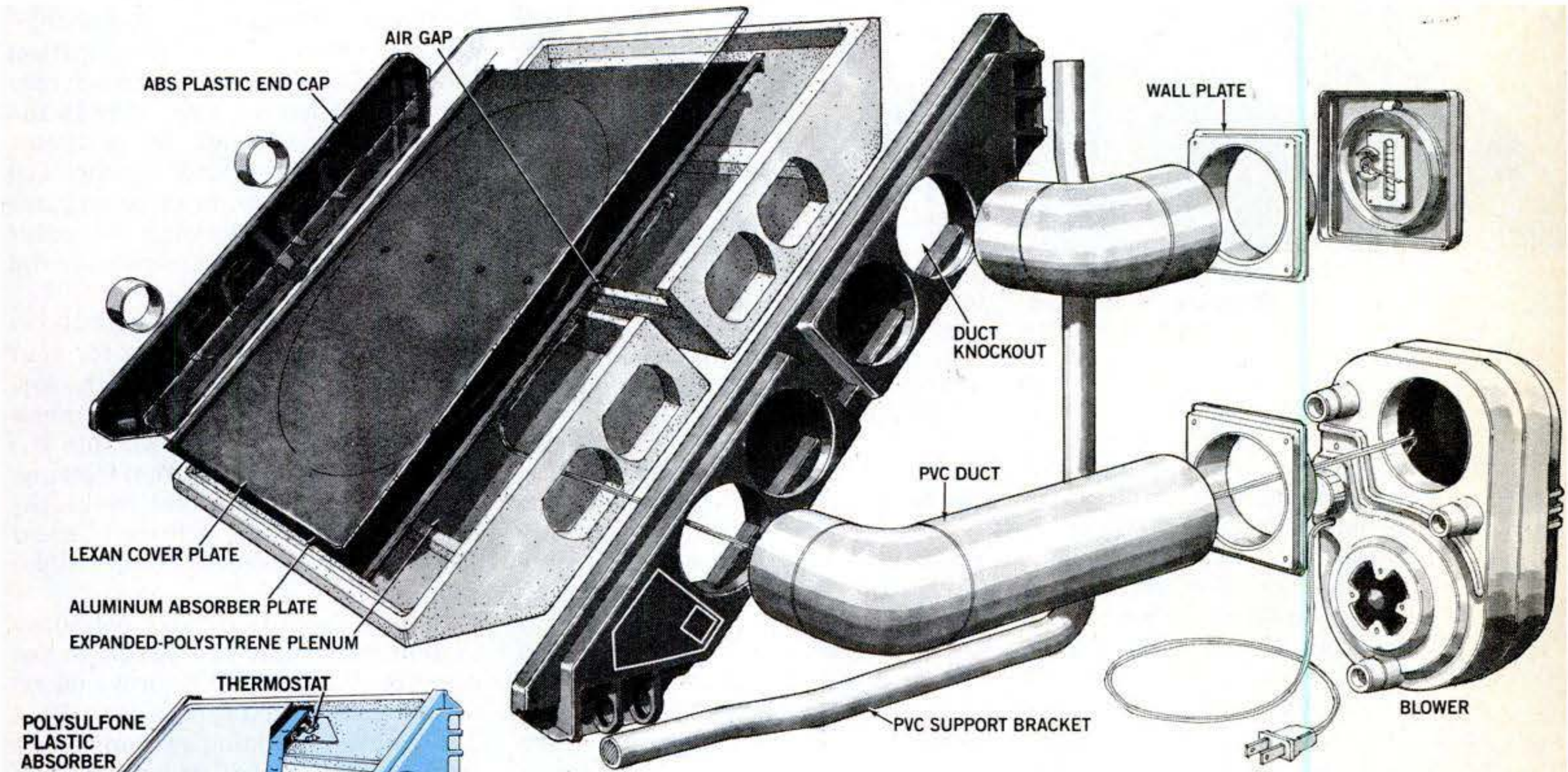
Savings in materials, fabrication, and handling have made the low price possible. Smaller size and weight—the collectors measure only 37 by 38 inches and weigh 15 pounds—also simplify installation. Modular design allows you to start with a basic two-panel system and add on later.

Tests show that on average the collectors raise air temperature about 30 degrees F. A pair will comfortably heat a 10-by-12-by-eight-foot room when it's 20 degrees outside.

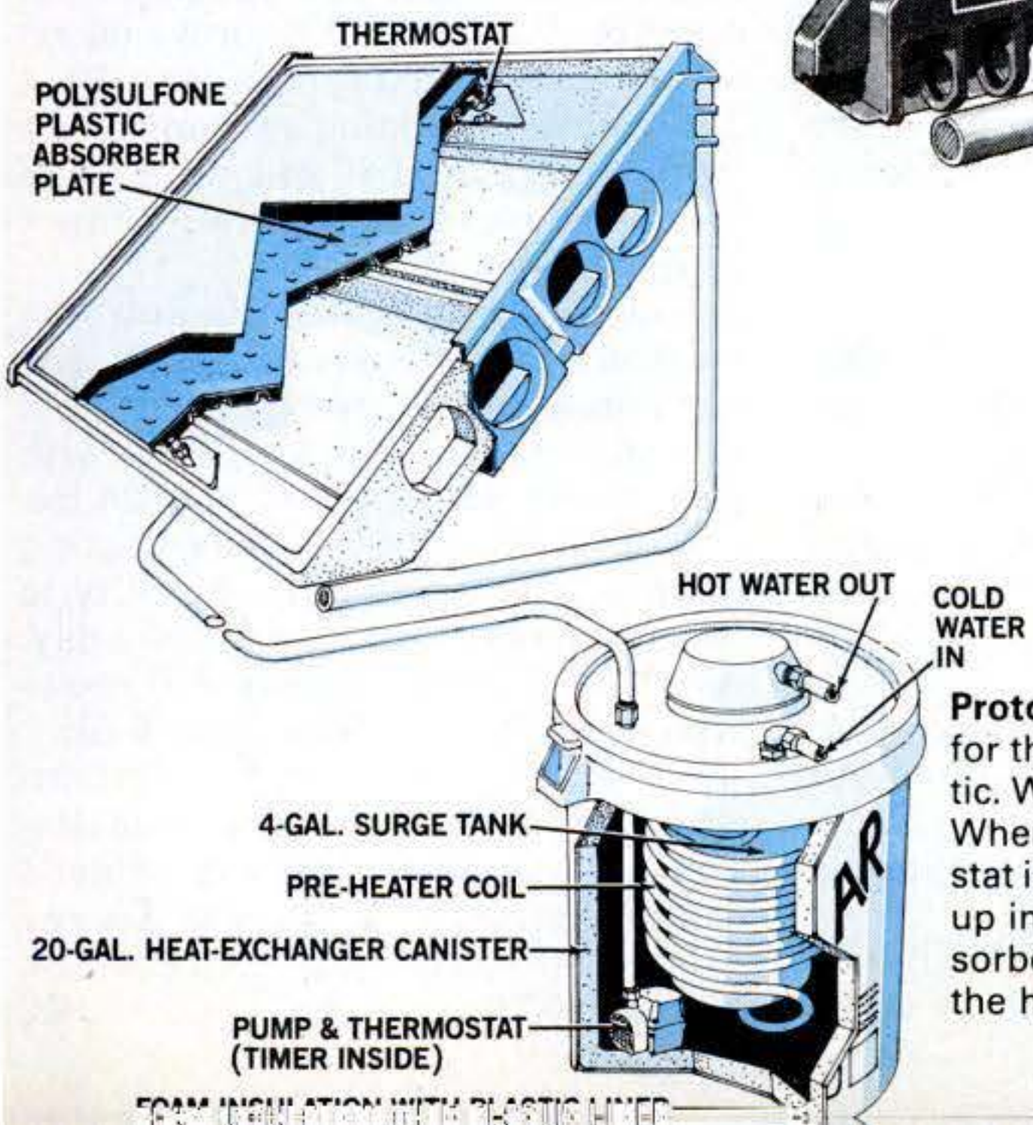
("This kind of result makes some people think of heating their homes entirely by solar collectors, but that ignores the cost-benefit ratio," Hanson warns. "If you size a system to supply half your yearly needs, you'll get practically a 100 percent benefit from your investment. But increasing the number of panels to supply *all* your needs may give only a 10 percent benefit for the added cost. That's because the larger system will supply more heat than you can use during most of the year.")

Hanson built and sold 100 space

Continued



In the space-heating version, a blower pushes cool room air through the bottom pipe into the lower plenum. Here it's blown up against the bottom surface of the aluminum absorber plate. Picking up heat as it goes, the thin film of air touching the plate rushes uphill through a narrow gap into the upper plenum. From here, the heated air moves through the upper pipe back into the house. Heating continues as long as the plate is above 70 degrees F.; this keeps the blower running.



Prototype water heater uses the same parts as air heater except for the absorber plate, which is made of high-temperature plastic. With its batch-type heat exchanger, the system costs $1,195. When the thermostat in the collector is warmer than the thermostat in the heat-transfer water, pump pushes a two-gallon charge up into the collector. Water moves through channels in the absorber plate, where it's heated until a timer lets it drain back into the heat exchanger. Cycle repeats until all water is heated.

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Installing a pair of hot-air collectors takes a beginner about four hours: (1) Mark position of mounting brackets for panel farthest from point of air entry into house; slide brackets into panel and mount it on wall. (2) Slide brackets into second panel and fit that onto connecting rings inserted into side of first panel. (3) Fasten brackets of second panel to wall. (4) The final step is to connect PVC pipe or hose from second panel to house and seal all joints with silicone caulking.

heaters that first year, 1979. As his second step he listened carefully to his early customers describe their experiences installing the system and asked how they liked its modular design.

With user comments in mind, Hanson turned out 250 units the second year. This time he sought customer reactions to the system's appearance—especially the collector. Based on these reactions he put together 300 systems the third year. Since then he's built 6,000 panels with only minor changes.

Hanson tackled the air collector for space heating first because, as he put it, "I'd rather save 50 percent of the 80 percent it costs to heat the average home, then save 50 percent of the 20 percent it costs to heat domestic hot water."

His design for the air collector started with the observation that only the thin film of air in direct contact with the absorber plate gets hot. The rest of the air in the collector warms up by mixing later with the hot air.

To increase the volume of air that actually touches the absorber plate and to keep colder air from diluting the hot air, Hanson devised a two-plenum collector. When the absorber plate reaches 80 degrees F, a thermostat turns on the system's blower. Cool air drawn from the house enters the lower plenum and flows in a thin stream along the underside of the absorber plate, passing through an air gap and into the upper plenum. From there it flows back into the house at the rate of 90 to 100 cubic feet per minute.

At 15 pounds the Hansolar TA-3 is a flyweight among collectors. What makes that possible is its main structure, two plenums of injection-molded expanded polystyrene. Plastic end caps, cover glazing, and support brackets keep weight down, too.

New hot-water heater

Following his usual development method, Hanson built 300 prototype water heaters this summer. Continuous production will start next spring, using feedback from owners.

A glance at Hansolar T(H_2O) tells you right away that something is different: Only one tube joins the collector and the heat exchanger. That's because the unique water heater uses a batch process instead of a continuous two-pipe loop.

"We studied hot-water use," Hanson explains, "and found that most homes use not more than four gallons in one shot. Then we looked at hot-water collectors and found that generally they operate by continuous flow during the morning and behave like batch processors in the afternoon, when most hot water is used.

"So we said, 'Why not batch all the time?' " Hanson continues. "Normally a heat exchanger holds ¾ to one gallon of water, which, when it gets hot, just sits there until you open the faucet. Then cold water comes in to replace the hot. So you get one gallon at 120 degrees [F] and one at, say, 60."

To solve that problem, Hanson's inner (surge) tank holds four gallons of domestic hot water. The outer one holds about 10 gallons of heat-transfer liquid—ordinary tap water or chlorinated well water. Two-gallon batches of liquid shuttle between canister and collectors, their stay in the collectors determined by a timer. When the canister liquid reaches 120 degrees F, the system stops, regardless of the timer. Drawing hot water lowers the canister temperature, and the shuttle resumes.

If the collector temperature falls below a setting predetermined for your area by Hansolar's computer, the system stops. Thus, at night the heat-transfer liquid drains down into the canister, where it's safe from freezing. Since the liquid has no antifreeze, the heat exchanger has a more efficient single wall instead of a double wall for safety.

In a standard T(H_2O) hot-water system you couple two panels to one canister. But you can improve on recovery time, which ranges from 10 to 30 minutes, by adding as many as six more panels. And if you want more hot water on hand, you can connect more canisters.

Like the space heater, Hanson's solar water heater is simple, small, and light—making it inexpensive and easy to install. Filling a collector with water increases weight to only 24 lbs.

Hanson has 1,000 space-heating systems on hand and the capacity to turn out more at the rate of 200 a day. As explained earlier, only 300 prototype water heaters have been built.

For a solar planning kit that includes product information, installation instructions, and an owner's manual, send $2 to Hanson Energy Products, River Rd., Newcastle, Maine 04553. PS

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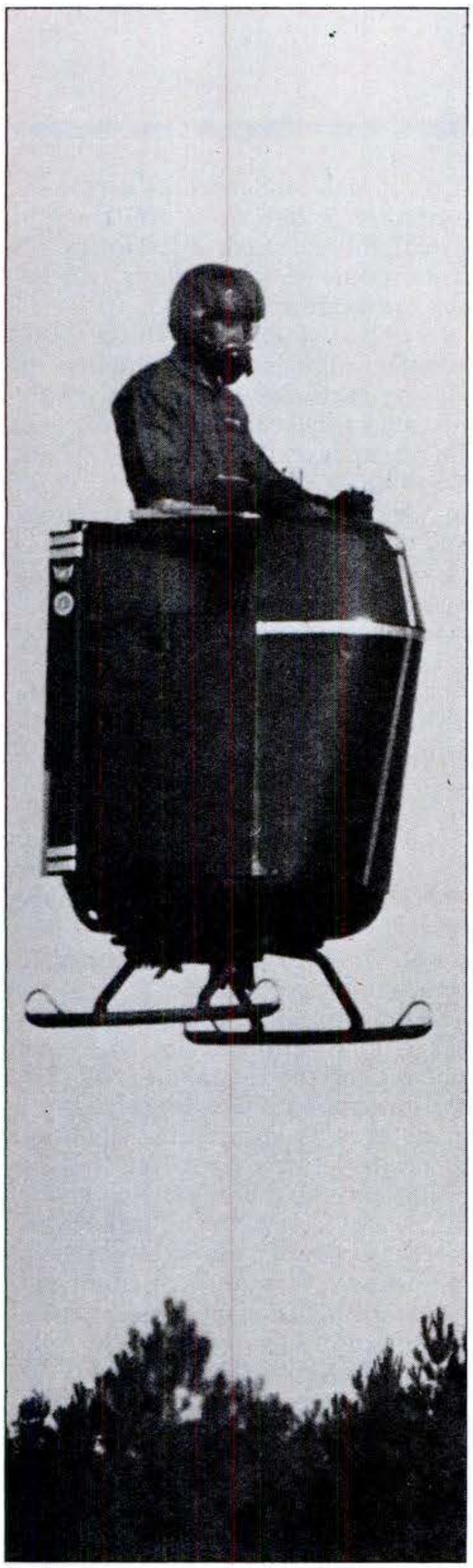
Turbofan-powered flying carpet



The ultimate in personal flying machines? It could be the Army's WASP II

By BEN KOCIVAR

An amazingly compact one-man flying device currently being tested by the U.S. Army can take off vertically and fly a man for 30 minutes at speeds of up to 60 miles per hour. Powered by the same two-foot-long turbofan engine used for cruise missiles [PS, Oct. '81], the WASP II (Williams Aerial Systems Platform) is the culmination of two decades of research. Among its startling features, the WASP II:

- Has no wings or rotors.
- Is so small it can fly its operator between and under trees and close to buildings and cliffs, and can reach places impossible with a conventional helicopter or other flying devices.
- Can land on a tiny, four-square-foot spot.

Some 20 years ago, test pilots for Bell Aerospace's Rocket Belt [PS, Dec. '61] learned what it was like to fly almost as free as a bird.

"It was like having a giant pick you up by the arms," reported Peter Kedzieraki, among the first to fly the belt. The first 13-second flight covered only 112 feet, just under what the Wright Brothers did on their first flight.

Bob Courter, a test pilot who made over 1,000 flights, says that later versions flew as high as 100 feet. But the hydrogen peroxide propellant gave only 21 seconds of free flight for a range of 300 yards. In addition, a team of skilled ground technicians was needed to handle the fuel.

The next step was the Jet Belt [PS, Nov. '69], basically a small Williams fanjet engine attached to a fiberglass corset, harnessed to the pilot's back.

The current model is a turbofan-powered flying platform with significantly improved performance. "We could probably fly as high as 10,000 ft. and as long as 30 minutes," Courter told me.

Just as surprising, the platform is not difficult to fly. In a recent U.S. Army demonstration at Fort Benning, Ga., three staff sargeants—none experienced pilots—made free flights after only three hours of practice. These involved 50 tethered flights. They were made at the rate of two a day.

The flying platform's midget fanjet engine, designed and developed by Williams International of Walled Lake, Mich., is the same 600-pound-thrust WR-19 bypass gas-turbine used in the air-, ground-, and underwater-launch cruise missiles. It powers that "thinking" nuclear-warhead carrier for distances of over 2,000 miles and speeds of 500 mph.

"For the WASP II, the engine is derated to about 545 pounds of thrust. This gives us much longer life and reliability," Courter says.

It's not exactly a stealthy machine. "The noise level is about like that of a small turbine-powered helicopter when it's close. But at about 1,000 feet away it's pretty quiet," says Courter.

The U.S. Army paid about $2.4 million for Williams to develop the first two test machines in a quest for greater mobility in the field. Unlike the original Rocket Belts, these are like podiums, each with two-feet-long jet engines positioned waist-high to the "pilot," who simply walks up to the machine, steps on the platform, starts the engine, and flies. Standing upright, he has two controls: a throttle on the right to adjust height and speed, a grip on the left to turn left or right. Pitch in any direction is accomplished by weight shift, as in some hang gliders. Fixed stabilizer fins act like a fixed rudder fin to provide stability. There is an emergency parachute in the top front compartment. It is deployed by an explosive charge like a shotgun shell that fires a three-pound weight. That pulls the chute.

The machine weighs only 245 pounds and carries 150 pounds of fuel, making it reasonably portable. The test platform has no fuel gauge. Later versions will include vertical-speed, altitude, and fuel instruments.

"Right now we have only flown it at heights of 60 to 70 feet," says Courter, "because at over 100 feet you lose visual cues, and it's hard to tell how fast you're moving up and down."

Courter sees civil as well as military uses for the flying platform. "High off the ground, it can help direct the fight against fires. And there are many rescue situations in tight quarters where other vehicles would just be impossible to use." PS

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Twin-rotor copter

is quicker, quieter, more maneuverable

The top rotor spins left, the bottom one spins right. Result: better performance —and no noisy tail rotor

By BEN KOCIVAR

"Having two overhead rotors on a helicopter is like having two cooks in the kitchen," Igor Sikorsky once told me. "They will not get along."

The genius of rotary-wing-aircraft development went on to explain the advantages of his single overhead rotor over the tandem-rotor designs developed by rival Frank Piasecki.

Now, a double-overhead-rotor helicopter is being developed by Sikorsky Aircraft, the company founded by the late proponent of single-rotor design. It is the XH-59A Advancing Blade Concept (ABC) helicopter. Sikorsky Aircraft designed and developed it under contracts with the Army, Navy, Air Force, and NASA.

The ABC chopper uses two sets of three-bladed counter-rotating rigid rotors mounted coaxially. They are used for lift; auxiliary engines provide forward thrust. The copter has no tail rotor. None of these features is unique; they have appeared in Soviet, German, British, and American helicopters. But combining all three in a single machine is unique. The result is a copter of exceptional speed, lift, and maneuverability—with low noise and vibration levels.

There's more than a grain of truth to the old saw of the aircraft industry that a helicopter is "a collection of spare parts flying in loose formation." Noise and vibration have been serious problems, and many copters are limited to speeds of about 150 mph. They are also expensive to buy and operate. But all of these problems are mitigated by a simple fact: You can do things with a helicopter that you just couldn't do otherwise.

New turbine engines, composite-blade construction, automatic flight-control systems, and new avionics have vastly improved helicopter performance in the last decade. "But the conventional copter's speed is still limited by its basic design," says Art Linden, Sikorsky's project manager for the ABC.

Here's why: When a helicopter is hovering, the airflow is forced down evenly past each blade. But as the rotor disc (the 360-degree path of the rotors) is tilted and forward speed builds up, the airflow changes. The blade moving forward now experiences airspeed that is a combination of the forward helicopter motion plus the forward speed of the rotating blade. At the same time, the retreating blade is experiencing airflow that is a combination of the rotational speed minus the forward speed of the helicopter.

"At about 180 knots, the tip of the advancing blade is reaching supersonic speed and drag while the retreating blade has so little air passing over it that it begins to stall. At this point you get serious structural vibration and stability problems," Linden explains.

The counter-rotating blades of the ABC design avoid this problem because the blades opposite each other (and turning in opposite directions) provide balanced lift at all times. Thus the loss of lift on the retreating blades is not a problem.

Sikorsky actually began research on ABC back in 1965. Ten years later, I first sat in the cockpit of the technology demonstrator in Stratford, Conn., when it was configured as a twin-jet helicopter. It flew up to 160 knots in level flight and reached 192 knots in a dive—speeds some of today's helicopters can achieve.

In 1977, two Pratt & Whitney J-60 turbojet engines were mounted in pods on each side of the fuselage for auxiliary forward thrust. Since then, the research craft has reached speeds of 240 knots (276 mph) in level flight and 302 mph in a seven-degree dive. And it has climbed to altitudes of 25,500 feet. It could go higher and faster if it had more-powerful auxiliary engines, the company says.

The present configuration of engines is less than ideal. The ABC copter has four engines. Only the two lift turbines have an interconnected transmission. The side-mounted J-60 turbojets gobble lots of fuel. "The ABC is not a prototype," Linden emphasizes. "It's a technology demonstrator." The production version will have convertible twin engine (see diagram). That will save weight and fuel, and enhance performance.

Despite the limitations of the current engine arrangement, it is clear that getting the rotors out of the forward-propulsion business has several advantages. A conventional helicopter moves forward by tilting the disc angle—and the copter body tilts with it. The ABC can do this in its pure helicopter mode. But when the auxiliary engines are providing forward thrust, the rotors and fuselage remain level—an important advantage for the military when sighting on a target.

Equally important, since the overhead rotors do not have to produce thrust at high speeds, their pitch is reduced—they are "unloaded"—and the blades rotate at a slower speed. They require little if any engine power as

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ABC copter attains 250+-knot top speed (vs. 150 for most copters) and 5,000-ft.-per-minute climb rate (vs. conventional 3,000).

they go into autorotation. The blade tips do not reach the supersonic shock speeds that cause abrupt drag rise and vibration. Besides providing balanced lift, the counter-rotating rotors also balance out each other's torque. That's why the ABC needs no noisy tail rotor. And that eliminates the long shaft and transmission.

With conventional helicopters, the tail rotor provides yaw (directional) control. With the ABC, yaw is accomplished by differentially changing the pitch of the two sets of rotors. The ABC turns away from the direction of the rotor with greater pitch, which causes greater resistance. This system of changing direction is used at speeds up to about 80 knots. "When the ABC goes faster, this system is phased out and dual tail rudders provide yaw control," Linden says.

The rigidity of the rotors is also an important key to the ABC's performance. The flapping, hinged blades of conventional copters add complexity and limit speed. The ABC's blades are made like giant, stiff propellers with continuous twist. The backbone of each is a hollow titanium spar tapered in girth and wall thickness from root to tip. This is covered with fiberglass, and the area behind the spar is filled with aluminum honeycomb.

When not whirling, the ABC blades are so stiff that the tips, 18 feet from the hub, deflect only ⅝ inch. The upper blades are set 30 inches higher than the lower ones. While they flex under extreme loads, the closest they have come to each other, even in extreme maneuvers, is 12 inches.

The rigid rotor makes the ABC helicopter much more maneuverable.

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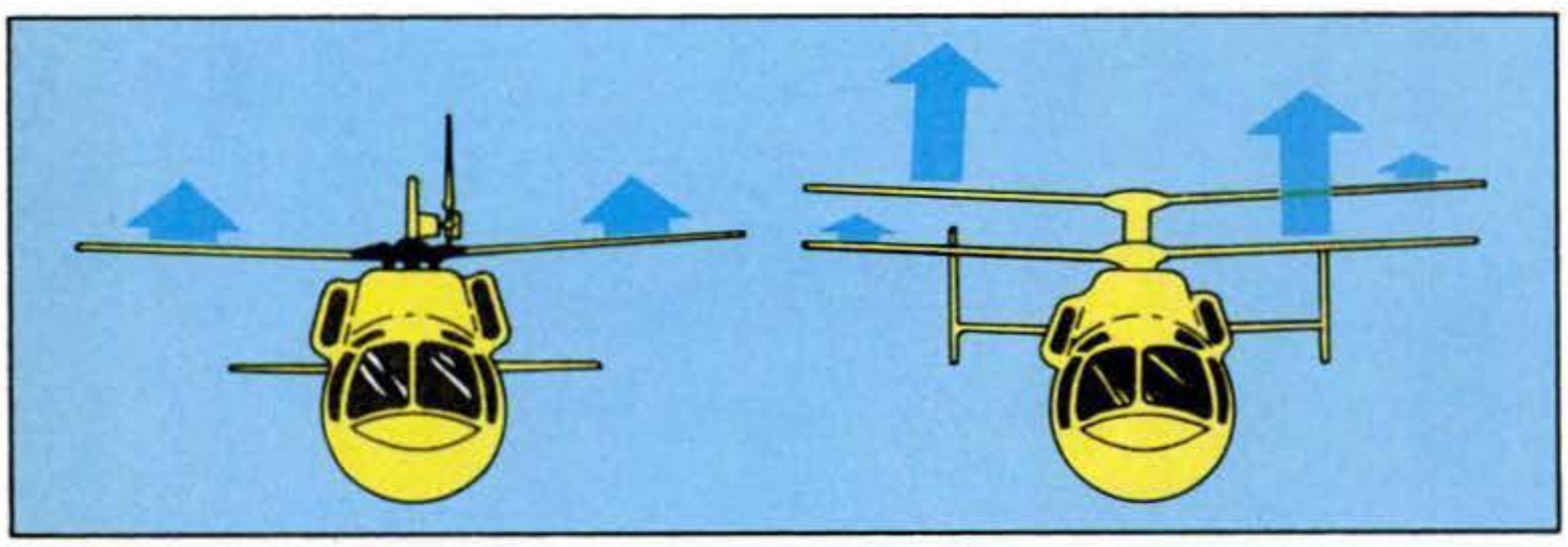
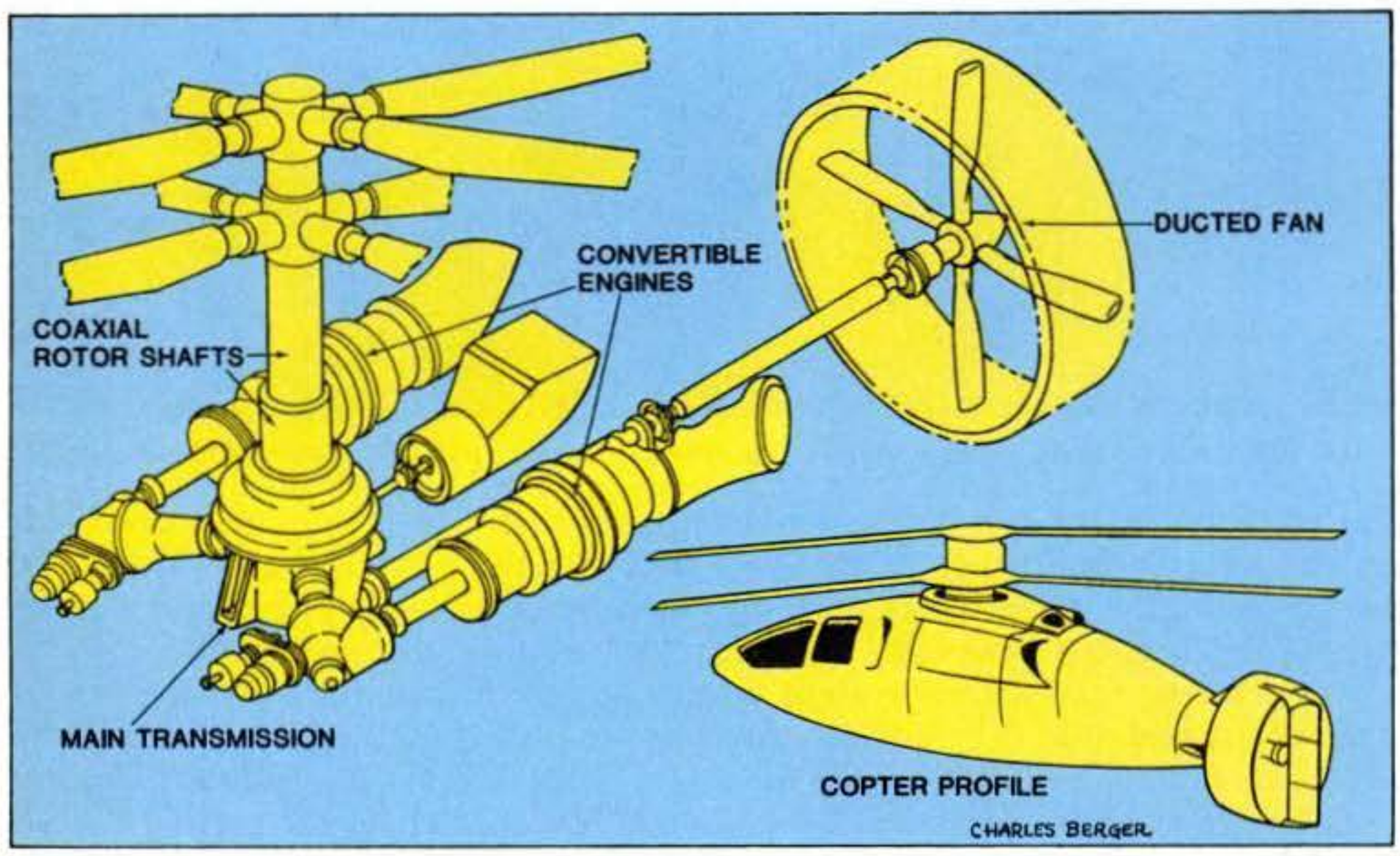
The ABC—with equal engine power and rotor diameter—provides 10 percent more lift than a conventional copter with a tail rotor. On some design variations, its airframe stays within the rotor disc. Such compactness aids maneuverability.



Conventional helicopter (above left) maintains balanced lift during forward flight by changing the pitch of its blades as they rotate. The advancing blade is at a lower pitch than the retreating blade because it is experiencing greater airspeed (see text). At forward speeds beyond 180 knots, the air pressure is so different on the two blades that the advancing blade tips may reach supersonic speeds while the retreating blade stalls. Thus control problems can become severe. With the ABC copter (above right), advancing blades—one on each side—keep lift balanced regardless of forward speed. Thus the retreating blades can be ignored.



Production version of the ABC helicopter would have two integrated, convertible engines. (The technology demonstrator has four off-the-shelf engines because of budget limitations.) The twin engines, driving a central gearbox, would power the coaxial rotor shafts, then shift to provide forward thrust. For this, the engines would drive either a tail-mounted ducted fan (as shown in this diagram) or side-mounted ducted fans or propellers. Such an integrated engine is now being developed by General Electric under a NASA contract. It is based on the company's proven TF-34 turbofan engine. A new transmission is being designed.

Conventional helicopters have been put through loops and rolls, but these must all be done keeping positive G loads on the rotors or they will fold down. That's bad news. A rigid-rotor copter doesn't have this limitation.

I asked Byron Graham, ABC project pilot, whether his machine had ever flown upside down, as a few rigid-rotor copters have done. "It's aerodynamically possible," he told me. "But in this test model the oil sump would not lubricate the engine and main gearboxes if we tried it."

For military use, the ABC's maneuverability is an outstanding feature. It uses this to fly low and fast, get in and out of tight places, and evade fighter planes and surface-to-air missiles. Army pilots report that the ABC demonstrator handles like a fixed-wing plane at speeds from 40 to 212 knots at absolute altitudes of only 40 feet while doing contour (nap of the Earth) flying in hilly terrain. Pilots were able to increase or decrease velocity by as much as 60 knots in five seconds.

What's the price of this performance? "If it were a 17,000-pound machine the same size as an S-60 Blackhawk, which costs about $3 million for the basic chopper, the ABC would come out about 15 to 20 percent more," Linden says. "But now you have something that does 250 knots instead of 150, and one that's quieter than a ship with a tail rotor."

"How about a civil airliner version?" I asked him.

"We have drawings for a 30-passenger airliner that would weigh about 30,000 pounds. A big ship like that could fly at altitude, be pressurized, and get over and around weather and traffic. But for now, the military needs come first." PS

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Ford's impossible plastic engine

How does a 152-lb., 318-hp plastic engine stand up to racing stresses? Ford will soon find out

By JACK KEEBLER
PHOTOS BY GREG SHARKO
ILLUSTRATION BY RAY PIOCH

Matty Holtzberg, president of Polimotor Research Inc., pointed to a green-and-black box shape on the floor of his shop. "That's our short block for the four-cylinder," he said.

As a former mechanic, I was quite familiar with the weight of both steel and lightweight aluminum short blocks. I tensed my muscles to lift a component that normally comprises a major portion of an engine's weight. I jerked the block clear off the floor with startling ease, and very nearly fell over backward.

This block was amazingly light because it was made of fiber-reinforced plastics (FRP's), also called composites. Making an engine that harnesses the powerful explosive combustion of gasoline out of a lightweight plastic might seem an impossible engineering challenge. But that's exactly what Polimotor, a small engine-design firm in Fairlawn, N.J., has been doing for several years. Its research is being backed by Ford Motor Co., which is spending a classified number of dollars to test, develop, and race an undisclosed number of plastic engines and components. I went to Fairlawn to learn about this impressive development in automotive engineering. It was a signal opportunity to examine the construction methods, advantages, and limitations of plastic—or composite—engines.

When I arrived at Polimotor, I found Holtzberg sitting in his office stroking one of two unusually large tabby cats that padded about the top of his desk, nosing among the scattered composite parts. The walls were bare concrete block except for some very elegant engineering drawings of the composite engine and a bookcase jammed with engineering reference books. Holtzberg told me that he was not the kind of person to work directly for a big company. "I like to try things," he said. "That's not to say I won't work for a big company someday." I noted that cats would probably not be allowed in a major company's engineering labs. He laughed. "You're probably right, and they're absolutely essential."

The Polimotor engine is based on Ford's trusty but heavy 2.3-liter four-cylinder. The Ford production engine weighs 415 pounds and puts out a maximum of 88 horsepower. Polimotor's twin-cam composite four-cylinder engine weighs a scant 152 pounds and is capable of developing 318 horsepower at 9,200 rpm, with a 14,000-rpm redline.

Holtzberg asked me to step into the dynamometer room. The all-black engine was sitting in the center of the room, and appeared to be tangled in a jumble of wires, cables, and hoses. From the doorway it looked like a disappointingly conventional design. But when I moved closer, I saw that the block did not have a smooth sand-cast finish. Instead, I could see the first laminate layer of interwoven carbon fibers embedded in the resin matrix.

Holtzberg started a huge fan to pull cooling air into the room. He then went behind the dynamometer console like a pianist about to play a concerto. His technician sprayed some starting ether into the intake velocity stacks and pushed a red button on the console.

The engine bucked, jiggled, snorted, and then burst into a rough, snarling idle. Holtzberg jazzed a joy stick on the console, and the revs screamed up and down. When I pulled my ear protector away, the noise was like a needle stabbing my eardrum. For about 15 minutes the engine wailed, and the tach needle on the console pulsed and surged in its Lucite rectangle. Holtzberg finally hit the kill button, and with relief I removed my ear protector. He was grinning from ear to ear.

Afterward, Holtzberg told me that his engine shares the same bore centers as the standard four-cylinder that has been powering Pintos and Mustangs for years. This enabled Polimotor to test the early composite heads and blocks while using the readily replaceable steel crankshaft and camshaft of a Ford engine. Otherwise, Holtzberg said, "the cost of tooling up a single crankshaft might have been as high as $80,000 or $90,000."

The engine's only other metal parts are the valve springs, bearing shells, exhaust valves, combustion chambers, ports, and cylinder liners. According to Holtzberg, Polimotor is working on a composite valve spring with some very promising, but still experimental, results.

The plastic material that made it possible for Holtzberg to build the revolutionary new engine is technically what engineers call a composite. A composite is a combination of two or more materials that generates a third material with properties different from (and usually better than) the

Continued

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original material. Reinforced concrete is a composite. The concrete acts as the matrix, and the steel rods give the material its great tensile strength. In the same way, various resins and fiber materials are combined to create FRP's, which are strong yet light construction materials.

Holtzberg's involvement began, he told me, when he started selling composite components, such as push rods, valve springs, connecting rods, and valve-spring retainers, to racers about five or six years ago. In 1979, Holtzberg remembers, he was sitting with "some people from Ford, and someone asked, 'You've made so many parts for the Pinto motor, why don't you make a whole engine?' " So he did.

Now Ford's Special Vehicles Operations Division (SVO) has launched a large research-and-development program based on Polimotor's work in composite-material applications in engine design.

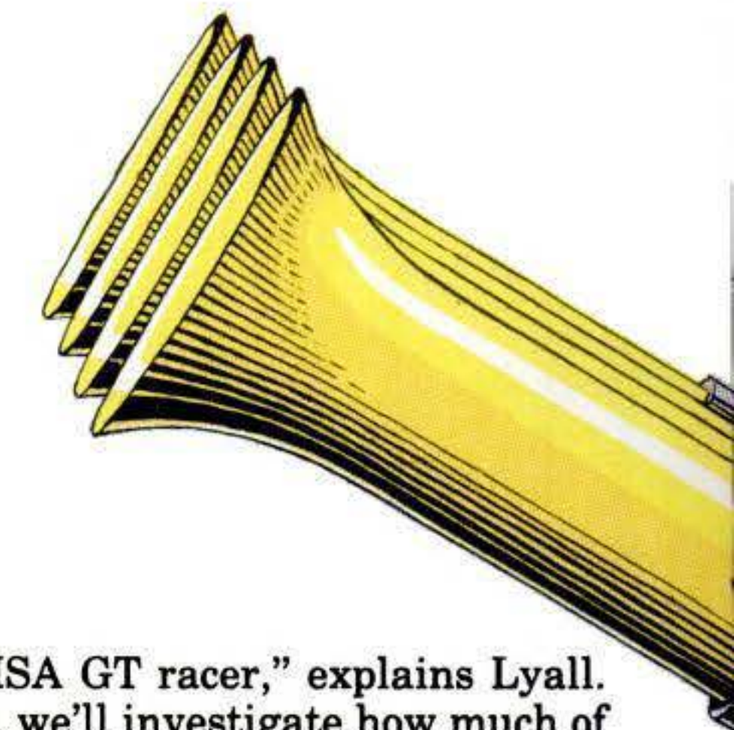
"SVO will test and demonstrate the composite materials in motor racing," explained Glen Lyall, engineering manager for SVO. "At first we'll be developing composite parts for this year's high-performance V8 racing engines. We're hoping that their use will help us with some valve-train problems we've been trying to solve."

Ford V8's will be running composite push rods, rocker arms, spring retainers, guide plates, and possibly a composite valve. If the initial tests prove successful, Ford will begin to look at more engine applications for FRP's.

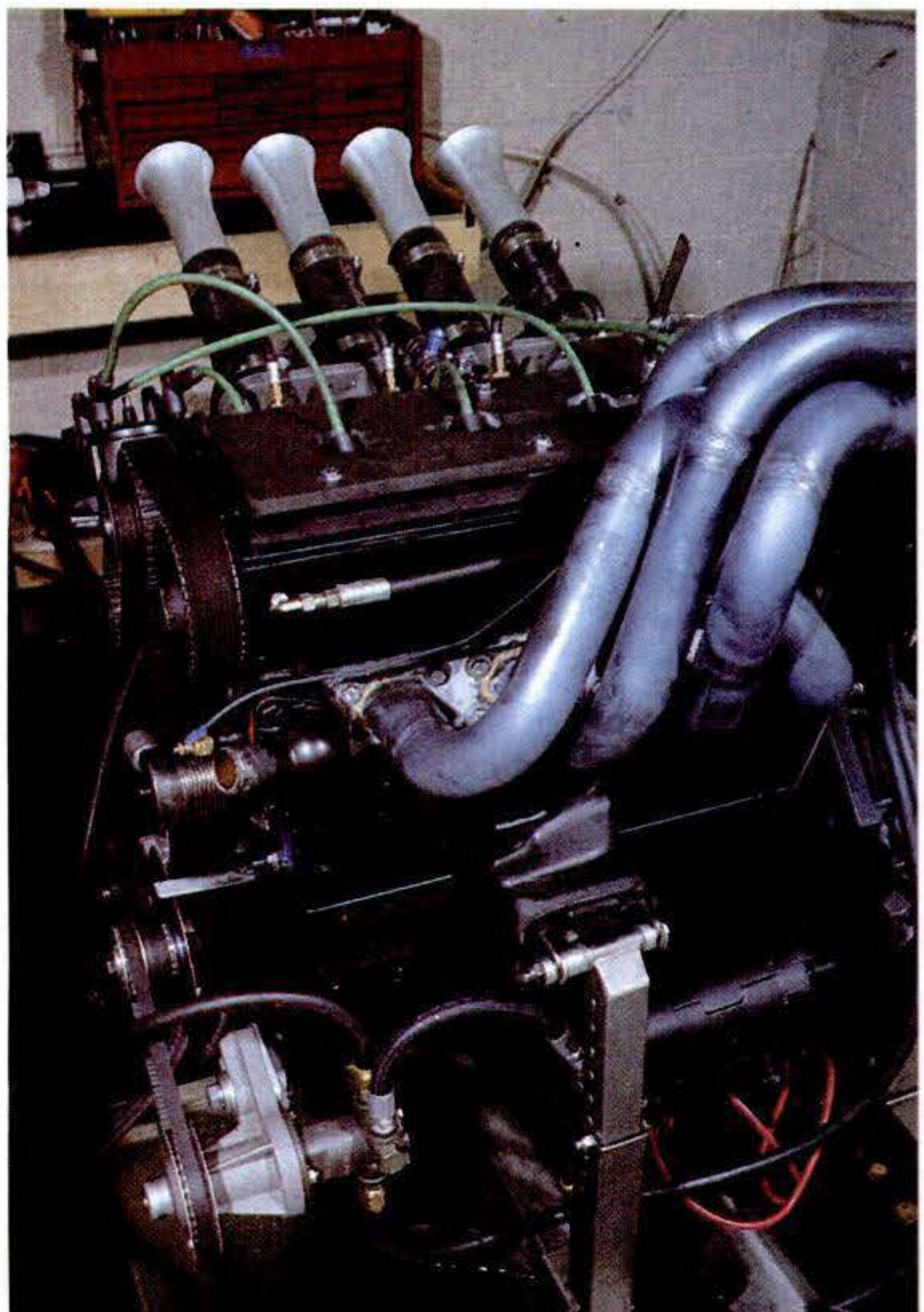
"During the first half of next year, we'll be working on an American high-performance four-cylinder for our IMSA GT racer," explains Lyall. "Later, we'll investigate how much of that engine can be converted to graphite-reinforced plastic."

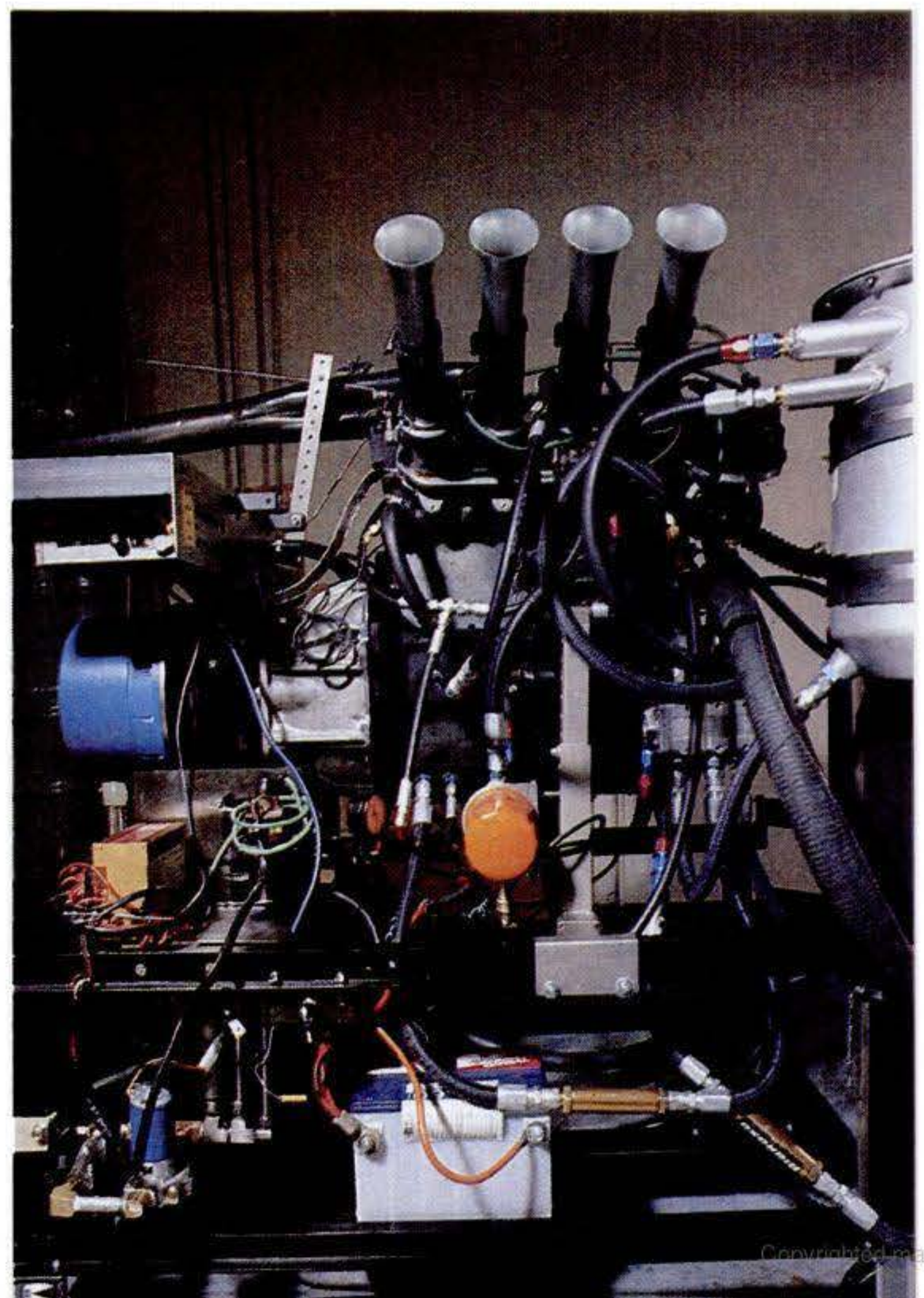
The obvious advantage in using FRP's is weight. Since most of the weight of an engine is concentrated in the block and head, that's where Holtzberg concentrated his development efforts. An additional benefit of composites is the inherent ability of plastic to absorb sound. Although no

[Continued on page 136]



Plastic connecting rod (top) rests in the hands of Polimotor president Matty Holtzberg. Composite push rods stand at his right elbow. A racing engine (below, left) made of carbon fiber and plastic was run on the dynamometer for PS. A dynamometer with the composite engine in position (below, right) is used to measure horsepower and torque during engine development.





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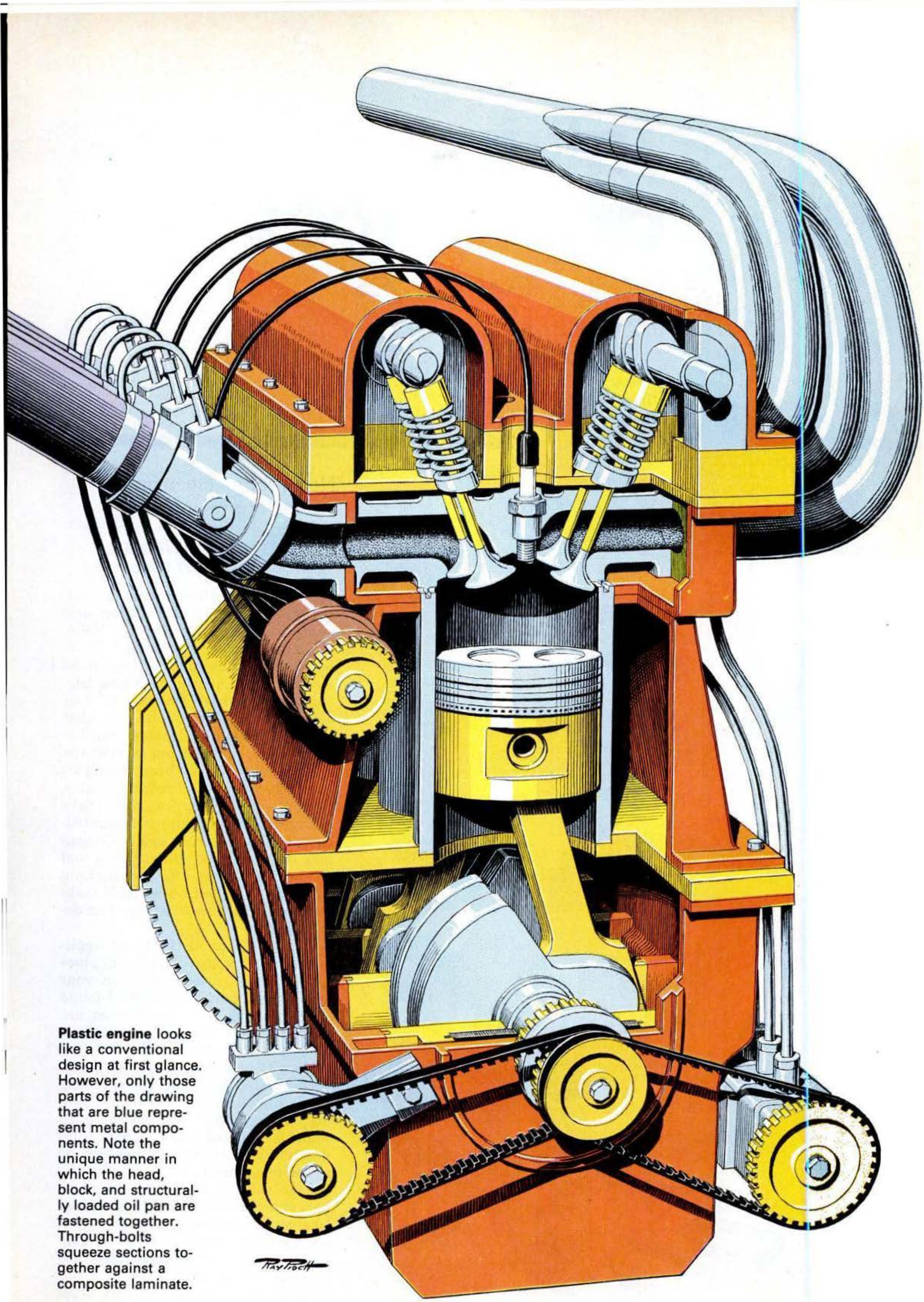

Plastic engine looks like a conventional design at first glance. However, only those parts of the drawing that are blue represent metal components. Note the unique manner in which the head, block, and structurally loaded oil pan are fastened together. Through-bolts squeeze sections together against a composite laminate.

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Talking appliances

—those new voices in your life

No escape—electronic voices are taking over

By WILLIAM J. HAWKINS
ILLUSTRATION BY ROY DOTY

Desk-top calculators recite the answers to your problem. Electronic navigators greet you with "Hello, Captain. Where are we going?" Typewriters read back your memos. Clocks constantly remind you it's getting late. (One even yodels!) Hold on to your earplugs: Talking appliances that use electronically created—synthesized—voices are booming everywhere.

Voice synthesis has been around for nearly 20 years, but it required costly, cumbersome electronics. Now that's changed. The miniature integrated-circuit chip has struck again: Companies such as Texas Instruments and General Instruments are making thumbnail-size silicon syllable-makers that cost a mere $10 to product developers.

It means that virtually all appliances in your home, car, or work place can soon be given a voice in your affairs. But should they? As I found out, some speaking appliances are quite practical—while others are just a lot of talk.

Usually, the voice you hear has been created by a human speaking into a microphone. The varying analog voltage that represents each sound is digitized—converted into digital bits of information that can be stored in a memory for recall. But the human voice is extremely complex—tens of thousands of digital bits must be stored to accurately represent just one second of speech. A direct analog-to-digital conversion is simply impractical and expensive.

However, as Dennis Intravia, prod-

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PHOTO BY ORLANDO GUERRA

IC chip (this one's from GI) supplies power of speech. Talking appliances are, clockwise from bottom: Radio Shack clock cube, Panasonic and Sharp calculators, Votrax computer add-on, TI navigator, Mattel video game, and Sears clock radio in rear.

uct marketing manager for General Instruments, told me: "The human voice pattern is predictable. Only one to two percent of raw voice data needs to be stored to reproduce speech."

The process used to streamline the voice pattern is called Linear Predictive Coding. And the basic idea is quite simple.

The circuitry assumes—predicts—a voice pattern, but uses the stored raw digital data to alter it to create the exact sound required. The result is a complete voice pattern that can be amplified and reproduced by a speaker. It's astonishingly clear.

Better listen

"Starbase three is under attack," cried a male voice from the Mattel Intellivision game. Equipped with the company's Intellivoice module, new game cartridges from Mattel audibly warn you of impending doom.

It's not hard to imagine how games could be enhanced by speech. The first talking appliance, in fact, was a learning game from Texas Instruments called Speak & Spell [PS, March '79]. Since then, the company has come up with more uses for the versatile chip: A talking electronic navigation system, for instance, plots your course—then literally tells you where to go. And the TI 99/4A home computer has a talking option. It uses phonetic spellings to create sounds (as does the Votrax add-on [photo], which works with other personal computers). That means you can make the computer say virtually anything.

And from other makers, the list goes on: Clock radios give you the time. One, from Telstar, speaks in English, Spanish, Mandarin, Cantonese, or Taiwanese. And if that won't wake you, another, from Olympus, yodels. There are talking depth finders for your boat; gas, oil, and temperature monitors for your car; and a talking thermometer for—I hope—your mouth. There are talking calculators from Sharp, Canon, and Panasonic; a talking grocery checkout system from National Semiconductor; a talking photocopying machine from Sharp; pinball machines that yell when tilted; a black box that hollers "help" if you're mugged; and a car horn that simply yells at pedestrians. (It's in prototype; the maker won't reveal *what* it yells.)

Despite all these new ideas, however, the future of talking appliances is uncertain. "What we've learned so far," says Intravia, "is that speech must be useful to the product. It can't be a gimmick."

In some cases, it's far from gadgetry. The Cardiac Resuscitator Co., for example, sells a resuscitator that gives its operator oral instructions in an emergency. Mura Corp. makes an automatic dialer for your phone: When the call goes through, a synthesized voice asks for specific help. Sears will soon offer a Braille version of Speak & Spell. IBM has a talking typewriter for the blind. And a speaking EXIT sign from Exit-Us directs the way out of a smoke-filled room.

But consumers are a finicky bunch. To date, no one really knows what *kind* of voice is acceptable in our homes: Male or female? Happy? Friendly? Instructive? What age? Should it have an accent?

"We don't even know if it should sound human," adds Intravia. "If it does, will it scare people in the middle of the night?" (The Navy found—not surprisingly—that male pilots reacted best when instructed by the synthesized voice of a young female.)

"Right now," says Intravia, "synthesized voice is where personal computers used to be a few years ago. We've got it—but now we've got to figure out what to do with it." PS

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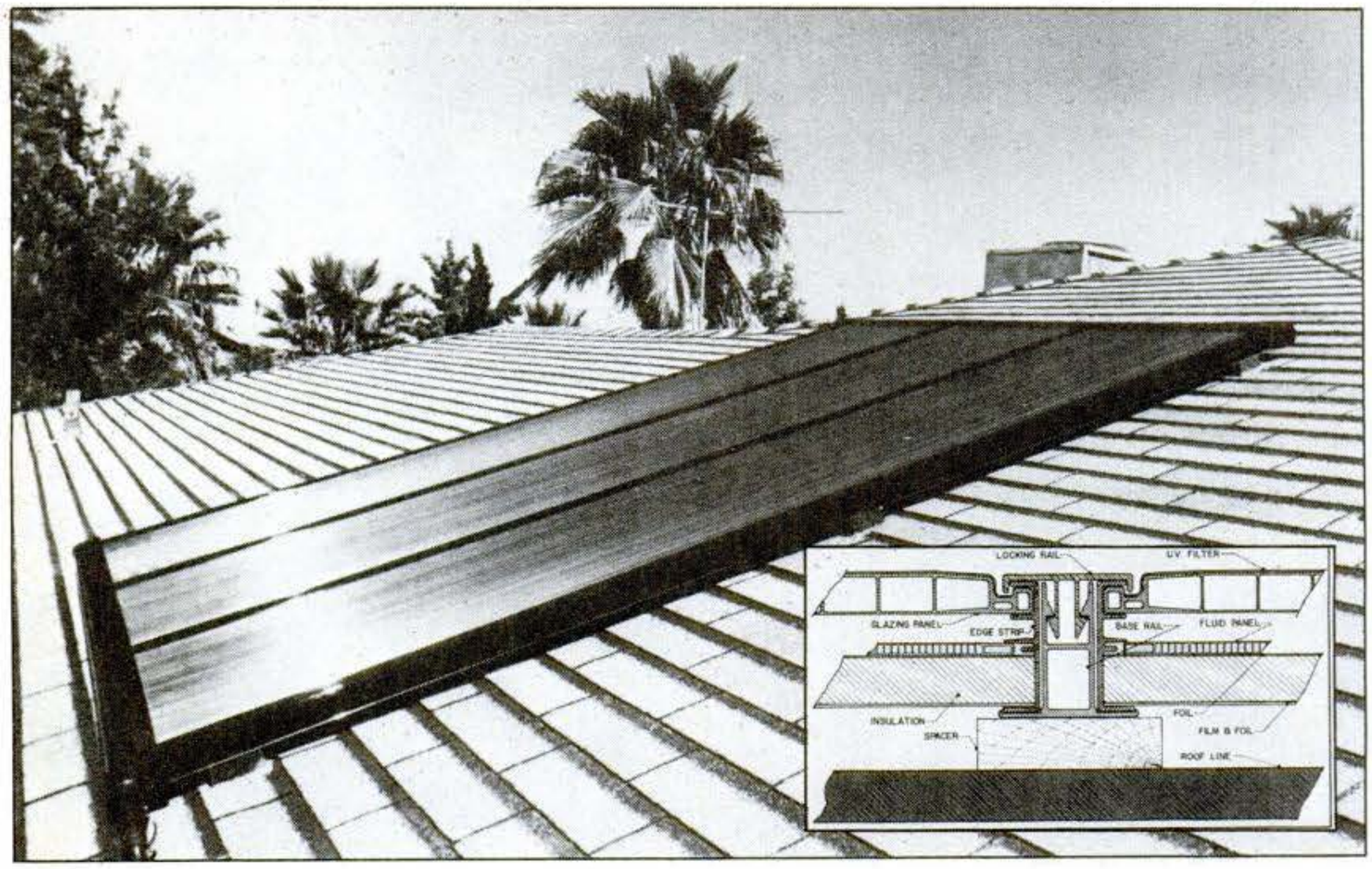
What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS

Card key

Check into a hotel with Yale-tronic locks and a computer assigns a unique code. A printer punches it into a card. When you insert the card in your room lock, a microprocessor analyzes the code. If it's correct, the lock opens and cancels the previous card.

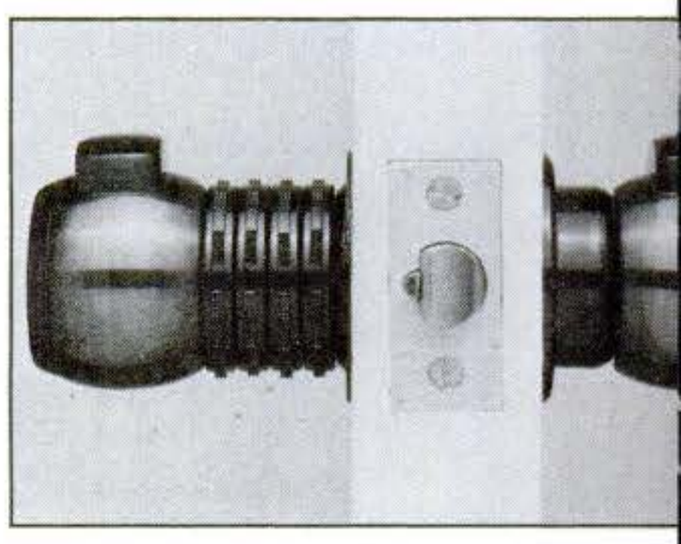


Plastic collector

Made of plastic by Ramada Energy Systems, Tempe, Ariz., these two-by-10-ft. solar water panels weigh only 30 lbs. The absorber plate is extruded polysulfone resin; the rest is molded transparent polycarbonate resin from Mobay Chemical Corp., Pittsburgh. Cutaway shows construction.

No-key door lock

Only the correct four-digit number gets you past the Keyless Doorlock. Rotate four rings on the doorknob's shaft; you can change the combination yourself to any of 9,999 variations. Exclusive Imports, 104-566 Lougheed Hwy., Vancouver, B.C., Canada V3K 3S3.

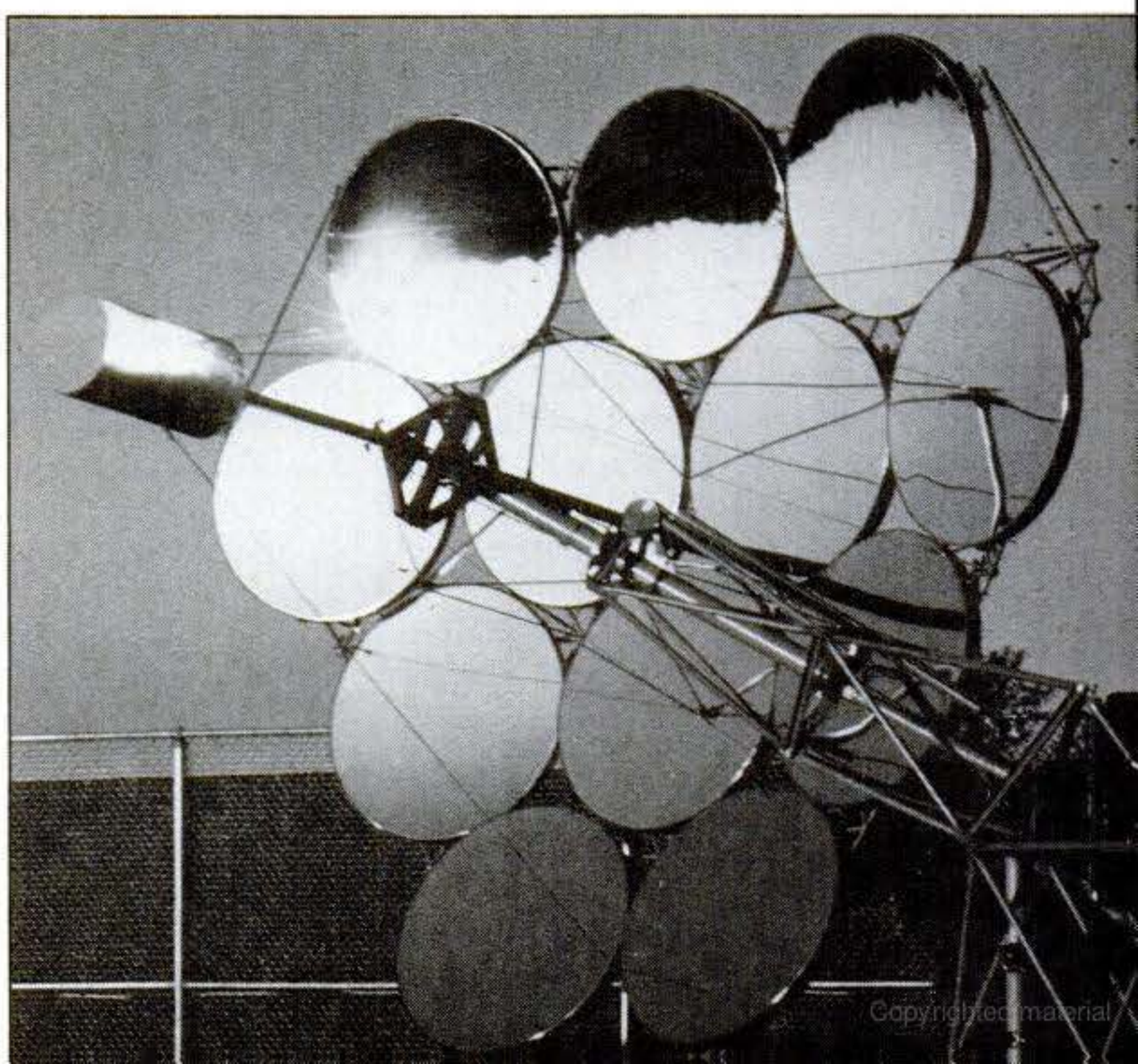


Sporty coupe

Latest Nissan Pulsar EXA coupe has retractable headlights, a more aerodynamic shape, and air dams that blend into the bumper. It shares 1.3- and 1.5-liter engines with other Pulsars and offers a four- or five-speed manual or three-speed automatic transmission.

Solar concentrator

A dozen curved mirrors instead of one focus the sun's rays on a single point in La-Jet Energy's parabolic concentrator. The Abilene, Tex., company made the mirrors of a thin film that's inexpensive to replace. The cantilevered frame unbolts for easy shipping.



Digital scale

You can see eye to eye with the Model 22 digital scale by Novus Electronics Corp. (28 S. Terminal Dr., Plainview, N.Y. 11803). Hang its remote display on the bracket provided and read your weight to a half pound or two-tenths of a kilogram. It's $60.

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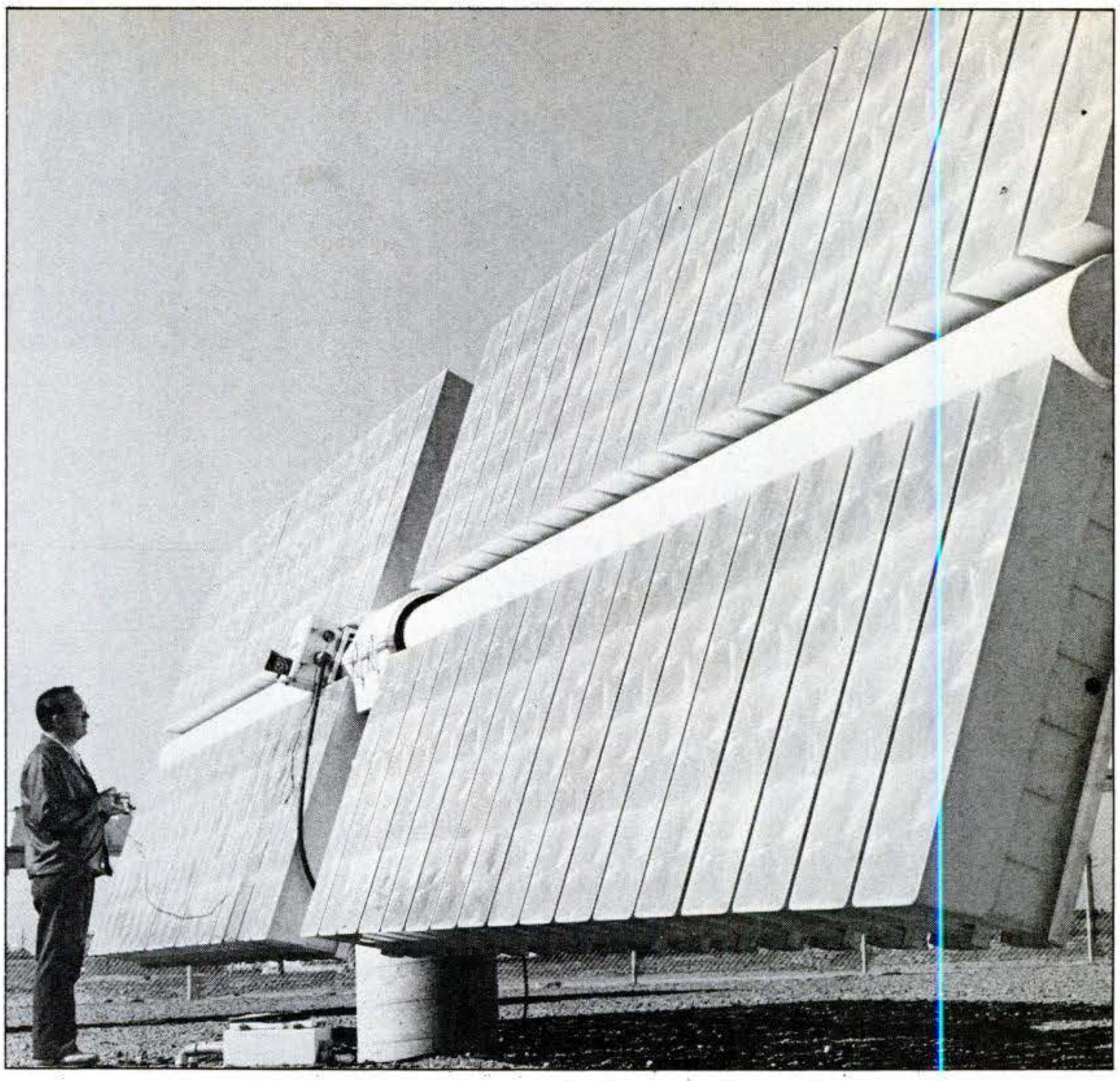
Sun charger

Photovoltaic cells power the instruments in remote monitors such as this for recording weather and solar radiation. Cells charge a battery for 24-hour use. Free Energy Systems, Inc. (Holmes Industrial Pk., Holmes, Pa. 19043), makes the charger.

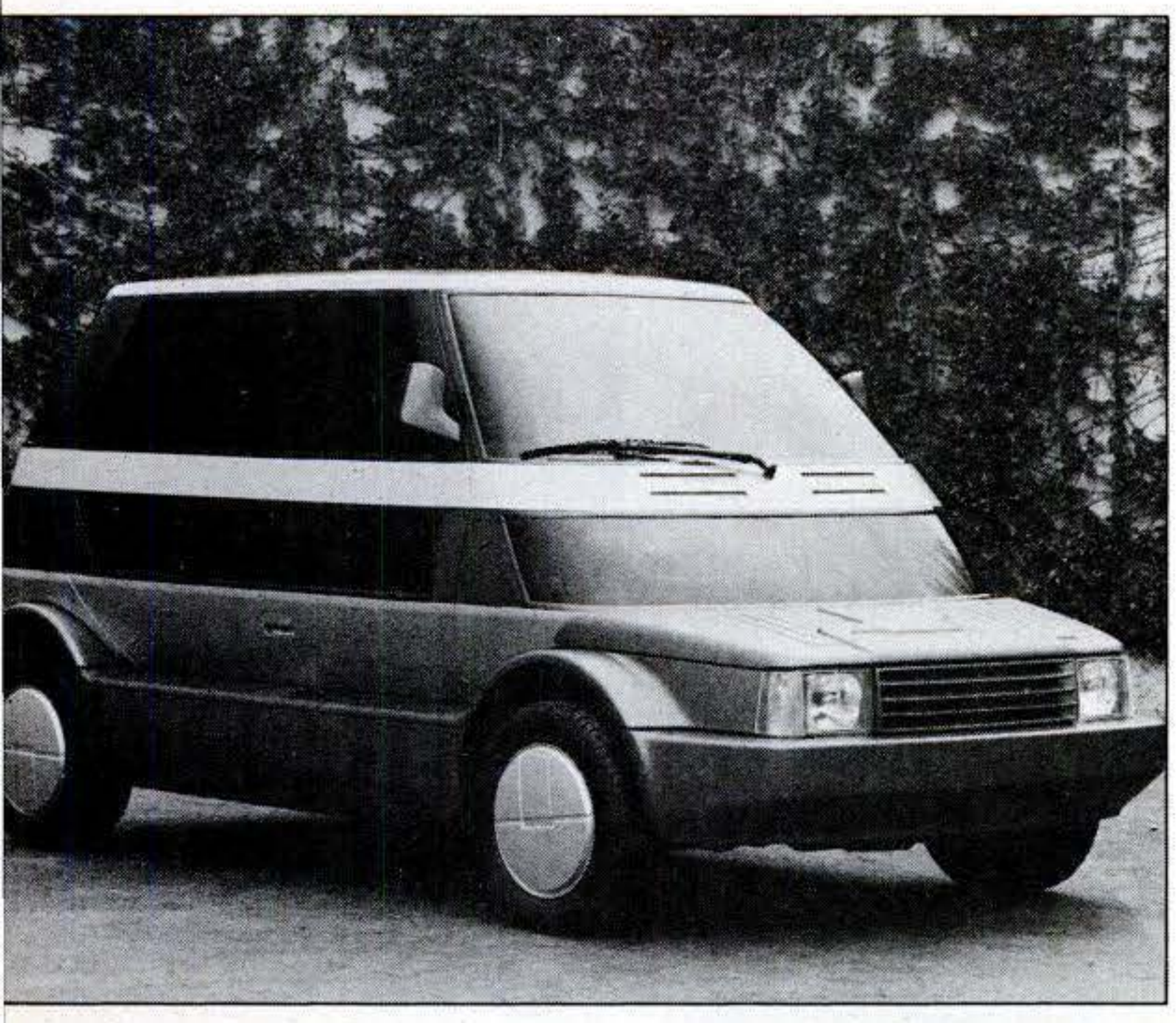


Full-time 4WD

A supercharged 1.6-liter engine drives all four wheels on Lancia's Delta Turbo 4×4. Said to have uncanny road grip, the 130-hp car does 115 mph. Tricky gearing transmits power from its transverse engine to front and rear through three differentials.

Solar power plant

Eighty arrays such as this with 21,000 solar cells make the Sky Harbor Intl. Airport facility in Phoenix one of the world's largest. Using Fresnel lenses and automatic tracking boosts output to 225 kW, enough for 40 homes. Arizona Public Service Co. operates it.

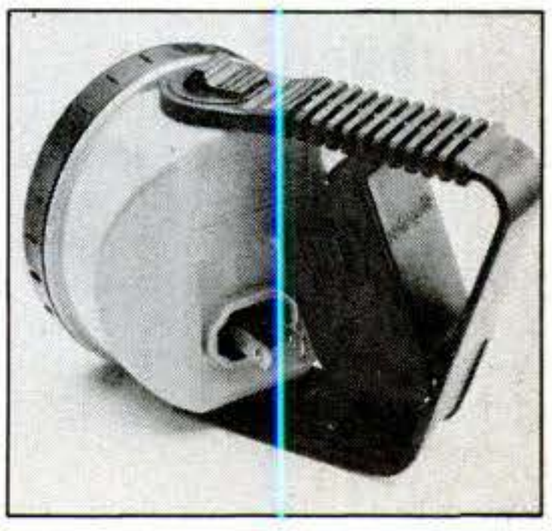


Convertible car

Now it's a van, but you can switch bodies on the prototype Capsula to make it a sedan, sports car, pickup, or ambulance. The bottom section contains a front-drive engine. Italian stylist Giugiaro of Ital Design, Turin, got the idea from interchangeable bus chassis.

Rechargeable spot

A highly polished three-in. reflector throws a bright beam for 60 to 80 minutes from the Sanyo Hand Light. Swinging the handle aside reveals an electric plug for recharging the 9.3-oz. light in 14 to 16 hours. L.L. Bean, Inc., Freeport, Maine 04033, sells it for $24.75.



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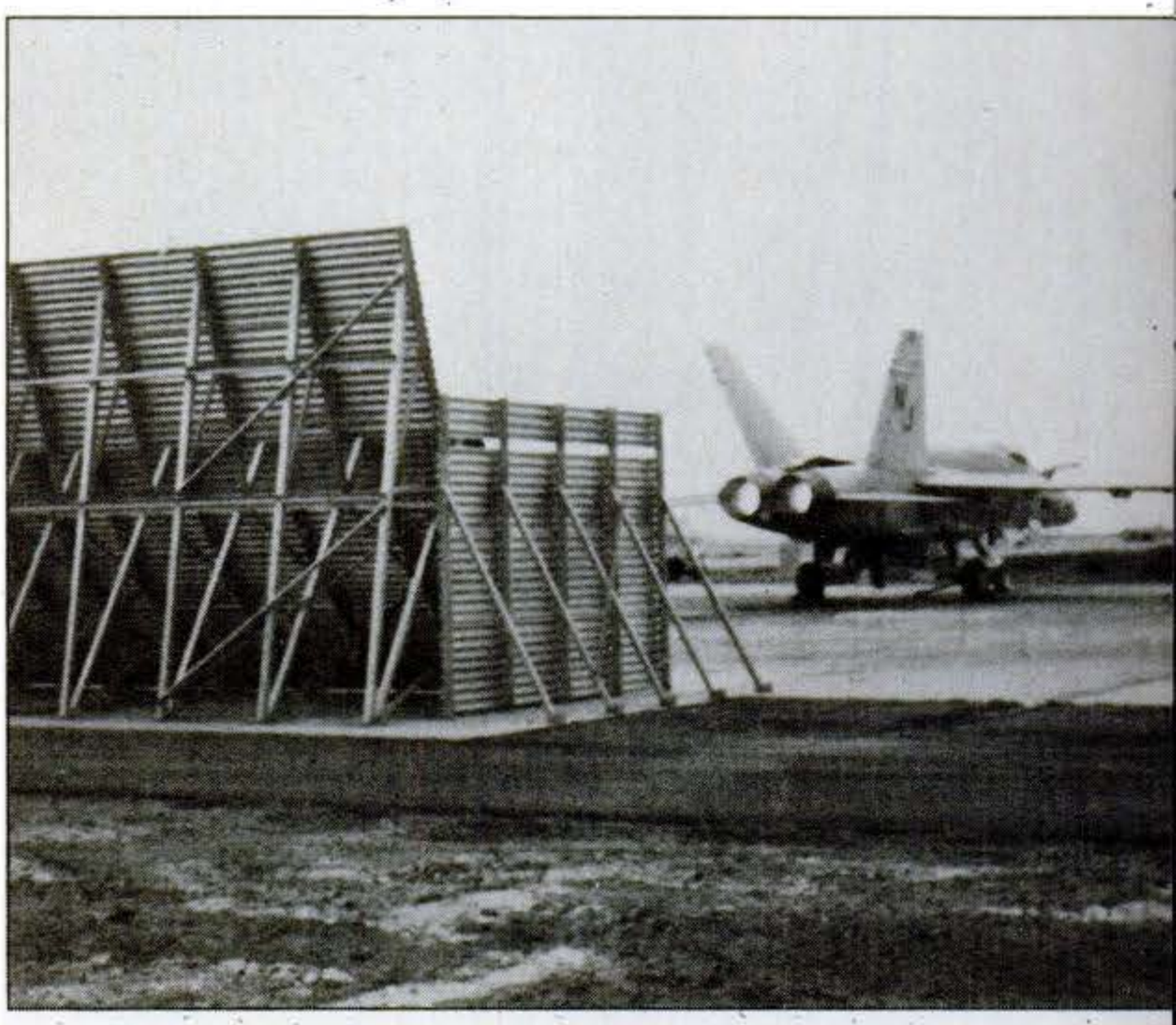
What's New

Peppy redo

The MG rides again, this time as a Metro 1300. It's a front-drive two-door, powered by a 72-hp, 1.3-liter transverse engine. It features independent suspension and a water-heated aluminum inlet manifold. Top speed is 101 mph, according to BL Cars, the British maker.

Lightweight armor

New U.S. Army head and body armor is made of Kevlar and ballistic nylon. The vest weighs 3.8 kg (8.4 lbs.) and comes with Velcro front closure, articulating shoulder pads, and high collar. The one-piece helmet protects the temples, ears, and neck.



Blast fence

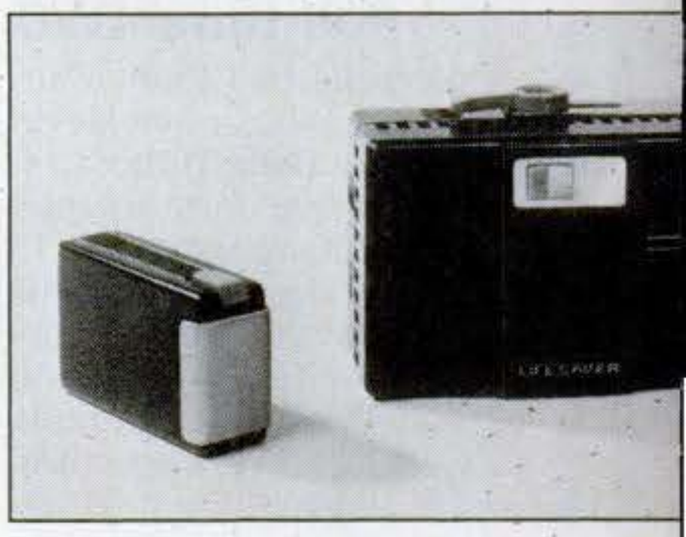
More usable space on a crowded runway apron is possible, thanks to Lynnco's GS-12 blast deflector. Even if a jet has two afterburners firing, you can walk behind the fence safely. The shield features equalization slots, end closures, and a low blast-entry angle.

TV phone

Glass fibers will carry the messages for this experimental videophone system, to be installed in seven German cities next year. The system, called Bigfon, will also carry videotex, radio, and TV programs. The government-sponsored project is being built by Siemens AG.

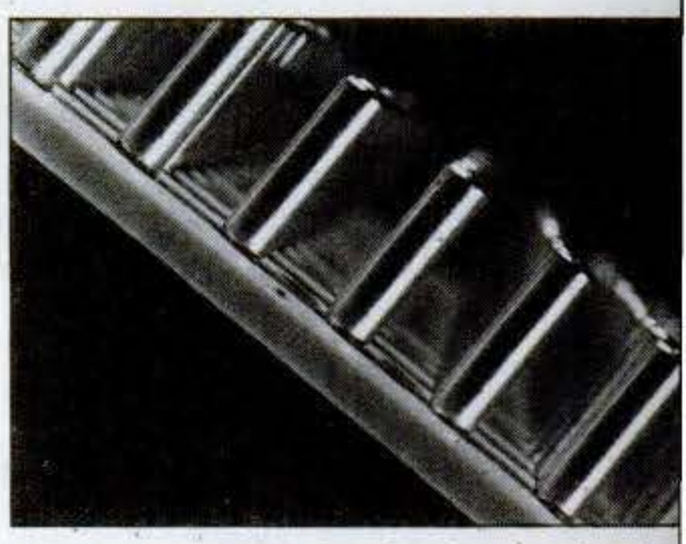
Travel alarm

The Lifesaver traveler's smoke alarm has a detachable light that turns on automatically, as does a loud alarm, if a fire is detected. Other features include a test button and low-battery indicator. Fyrnetics, Inc., 1021 Davis Rd., Elgin, Ill. 60120. Price: $33.



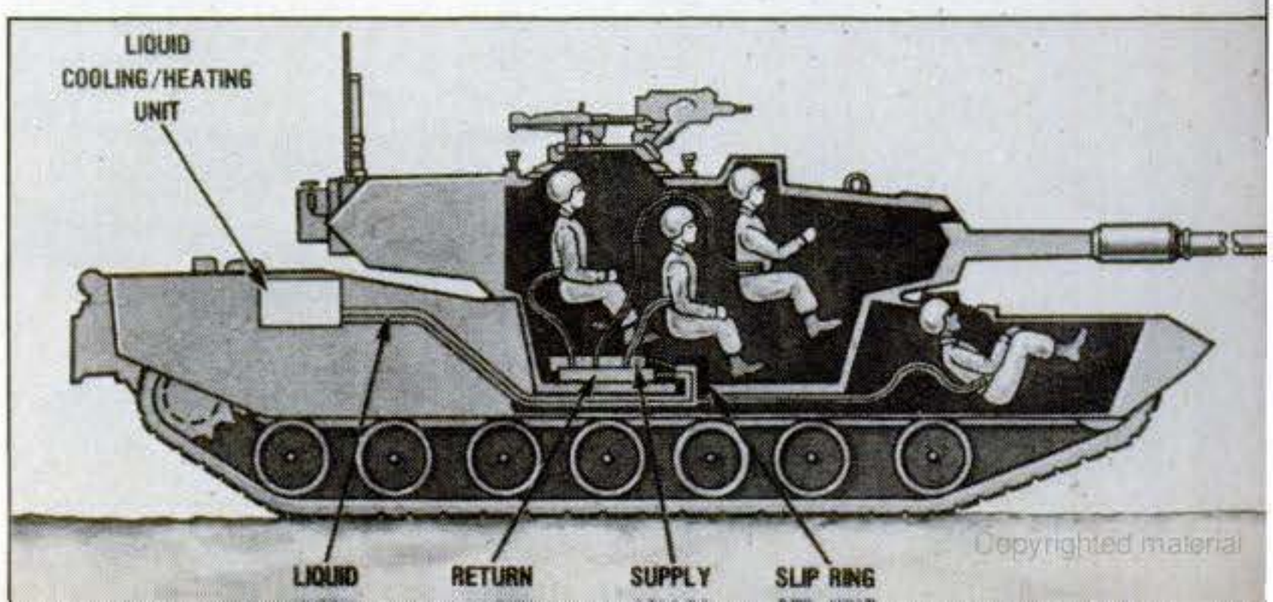
Chip carrier

The forest of the future? No, these are miniature heat sinks on the back of IBM's new multiple-layer ceramic chip carrier. It's been developed for high-density logic and memory chips. A single 86-by-63.5-mm carrier can hold all the logic functions of an IBM 370/Model 138.



Tank cooler

No need to cool a whole vehicle—this air conditioner for combat vehicles connects to the crew's vests. Flexible lines carry a chilled liquid to protect the soldiers at temperatures up to 140 deg. F. It's being tested by the Army's Mobility Equipment R&D Command.



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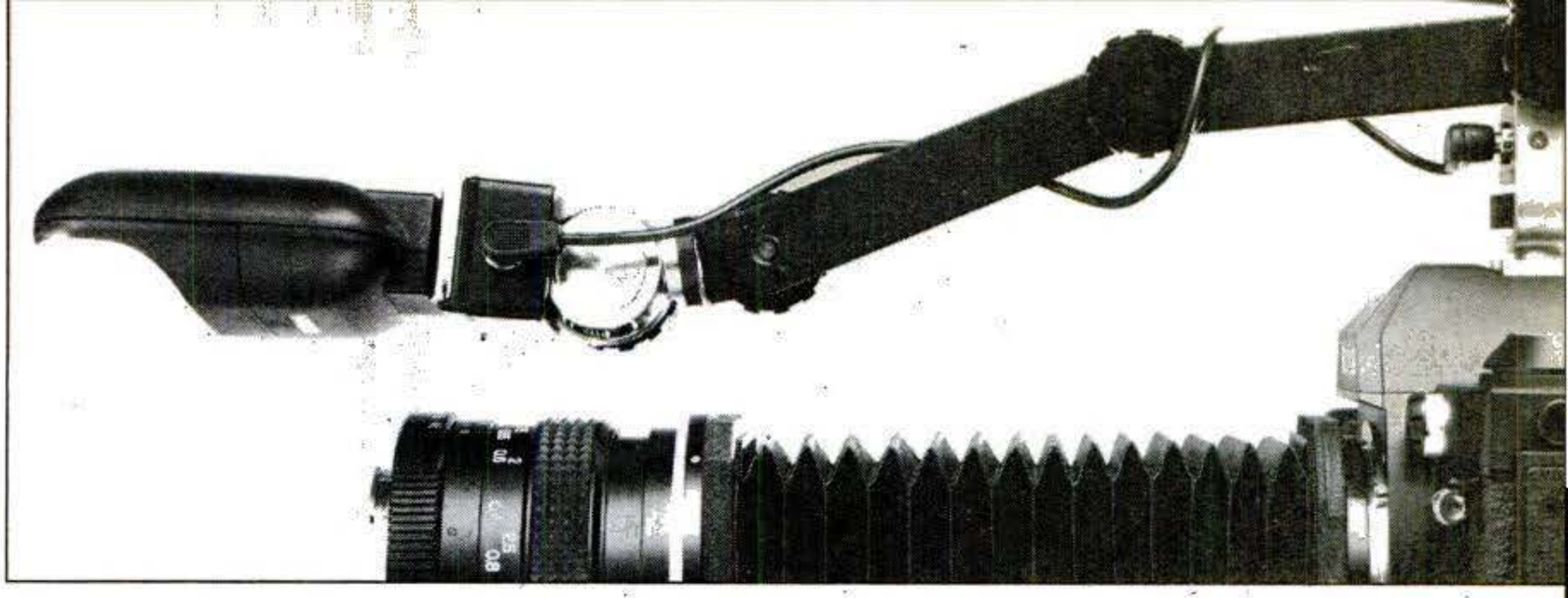
What's New IN PHOTOGRAPHY

BY E. H. ORTNER



Mini-flash for macro photography

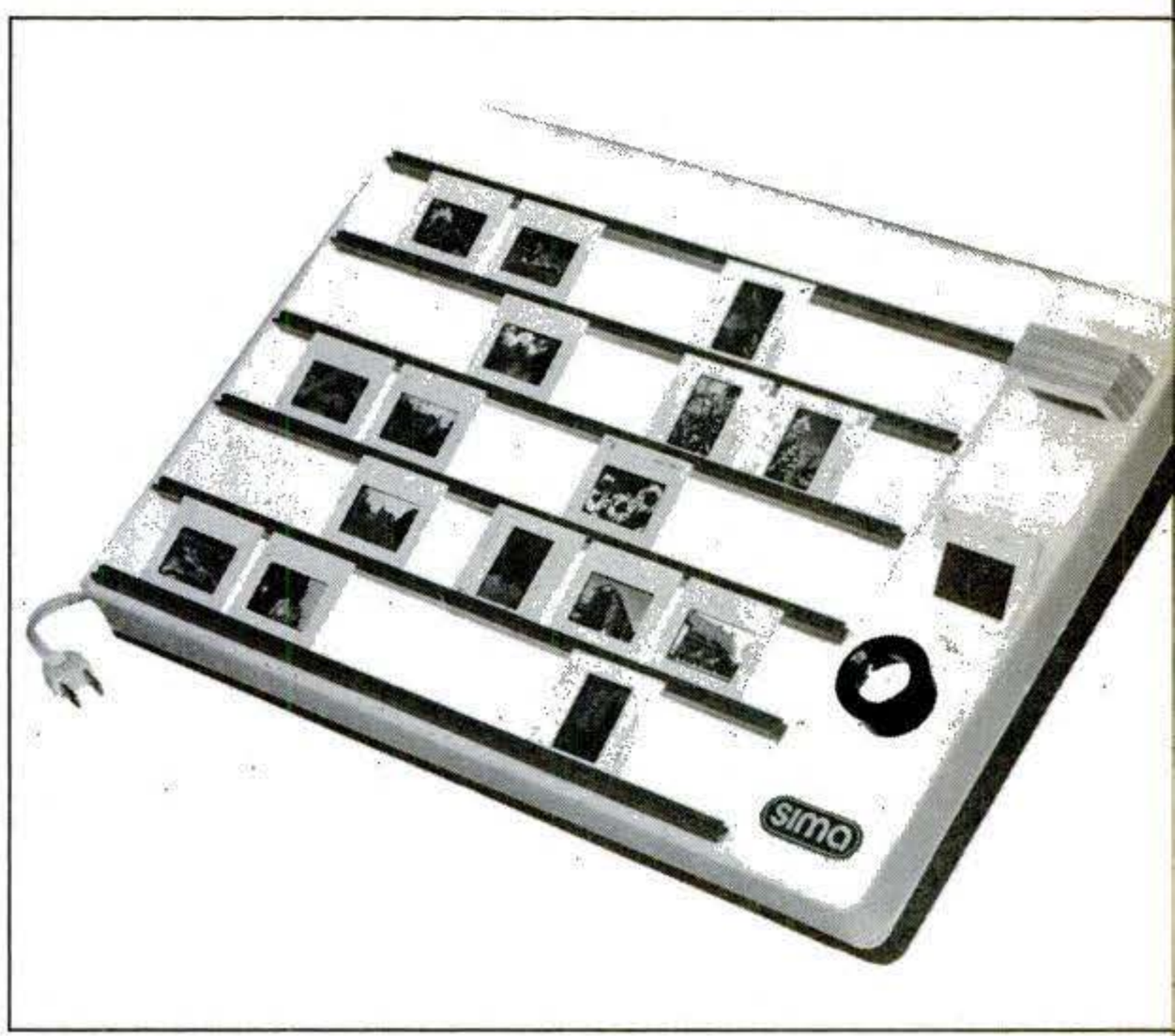
Mate a twist-and-turn bracket with a tiny flash designed for close-up work and you have the Spiratone Macro-Light system. The Every-Which-Way bracket ["Viewfinder," PS, Aug. '81] can put the flash in any spot within a radius of nine inches of the camera's shoe. The bracket's flash-synch connector mates the flash with either the camera's hot shoe or its PC terminal. The four-oz., 2-by-2¾-by-⅞-in. mini strobe has a guide number of 20 with ASA 25 film. It takes one AAA battery. The Macro-Light system (bracket and flash) is $39.95 from Spiratone (135-06 Northern Blvd., Flushing, N.Y. 11354).

Shifty bag

The Quick-Switch strap on this Quick Shot Traveler enables you to change from shoulder bag to fanny pack in seconds, says Richmond-Merritt (1611 S. Pacific Coast Hwy., Redondo Beach, Calif. 90277). It's made of Cordura nylon, has two adjustable dividers, comes in silver or rust. $49.95.

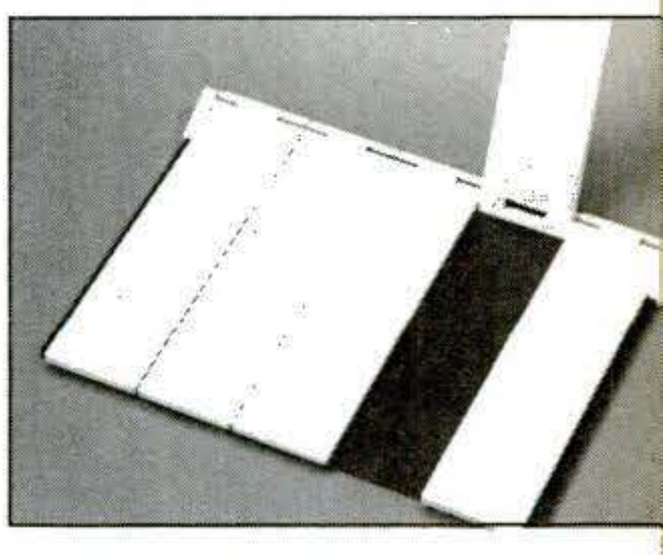
Slide viewer

A cool-white circular fluorescent lamp simulates daylight and supplies extra brightness in the Evenlite slide sorter. The sorter holds 42 slides, says the maker, Sima Products Corp. (4001 W. Devon Ave., Chicago, Ill. 60646), and has molded wells for extra slides and a magnifying loupe. Price: $49.95.



Test easel

It's easy to make side-by-side test strips with the Lambda easel: Just raise each of the five keys for a different exposure. For direct comparison, move the easel each time. It takes five-by-seven-in. paper, costs $18. Lambda Photo Products, 20993 Foothill Blvd., Hayward, Calif. 94542.

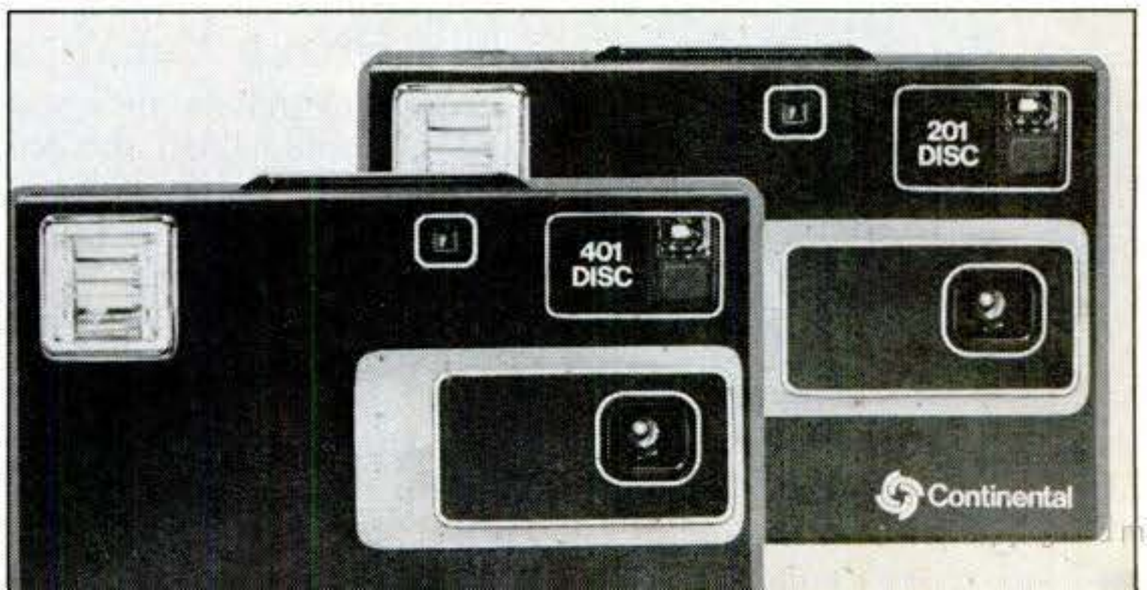


All-auto 35

Everything's automatic in the Konica MF: autofocus, autoexposure, autoload, autowind, and auto-rewind. What's auto-rewind? At end of roll, a beeper tells you to flip a switch so the camera can rewind the exposed film. There's an automatic built-in pop-up flash, too. List price: $249.

New discs

Move over, Kodak—now Continental has disc cameras, too. Both 401 and 201 models have built-in flash, but the 401's is automatic: It turns itself on and off. Fixed-focus lenses have a depth of field extending from four ft. to infinity. The 401 is $59; the 201 is $44.50.



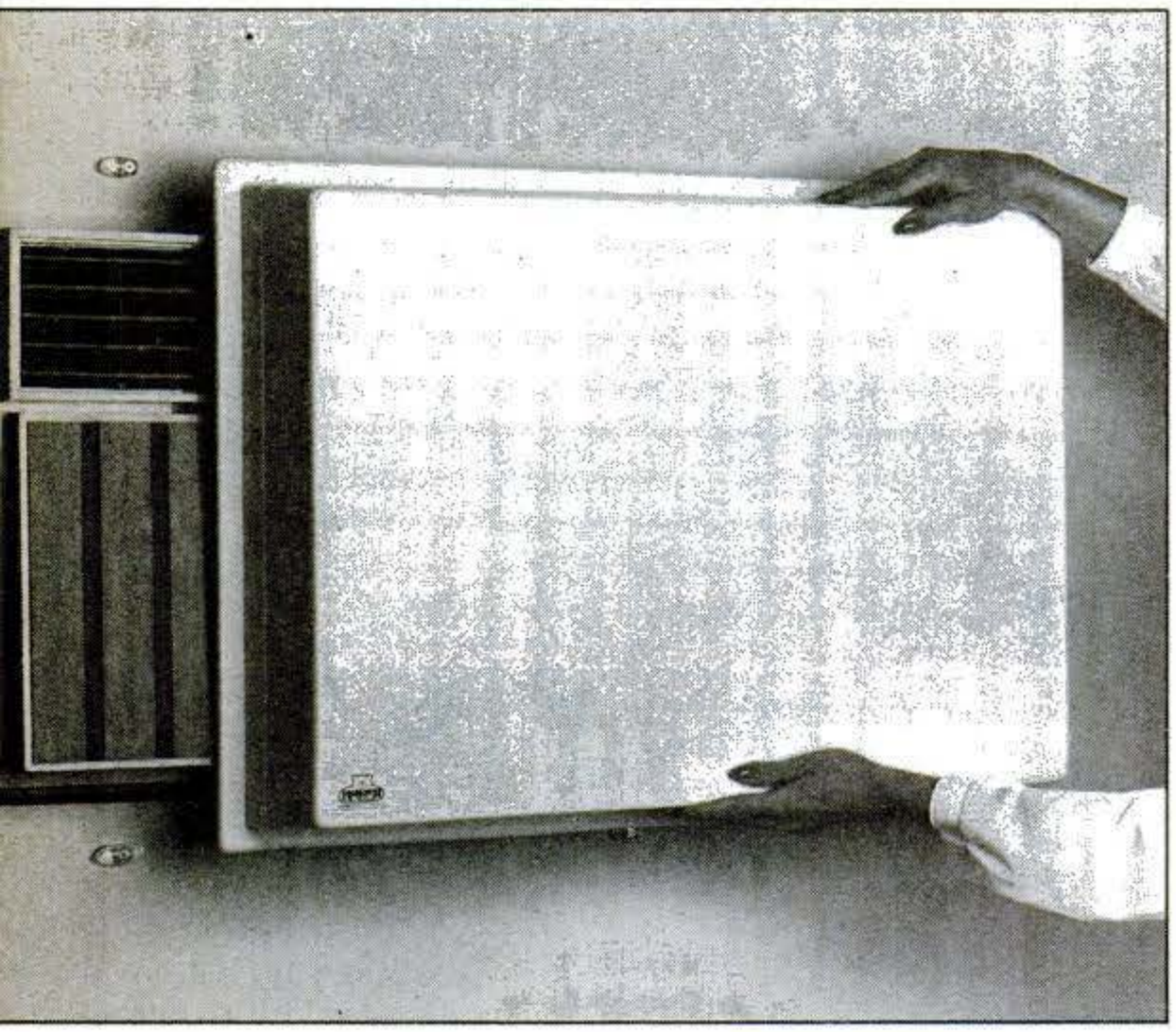
What's New
IN HOME IMPROVEMENT

Tape drive

The Genie Trac-Drive garage-door opener uses a perforated-tape drive made of Du Pont's Dymetrol. It doesn't need lubrication, won't stiffen in cold weather, and is quieter than screw or chain drives, claims the maker, Alliance Manufacturing Co., Inc. (Alliance, Ohio 44601). $240.

Instant stain

How do you deal with louvers, shutters, furniture legs, and other hard-to-finish surfaces? Stain them with Zar's Spray Stain. It stains and seals in one operation, says the maker (United Gilsonite Laboratories, Box 70, Scranton, Pa. 18501), and comes in six colors for $4 per can.

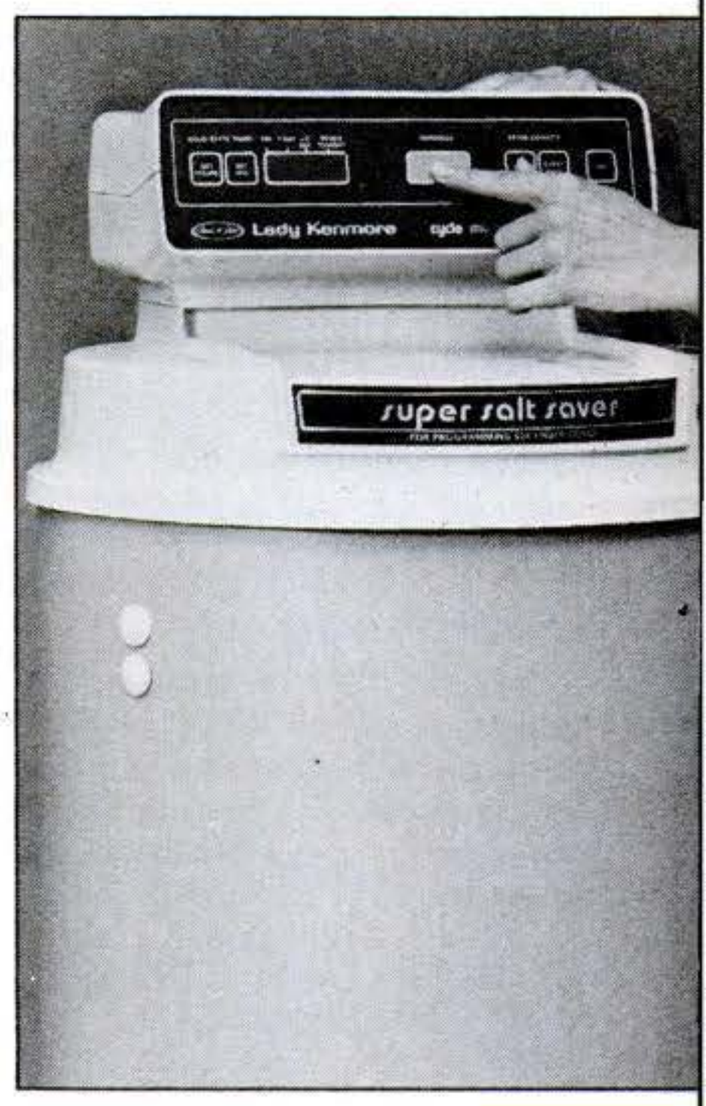


A/C cover

The Hugger installs over a through-the-wall air conditioner in winter to cut air infiltration. Heat savings with the unit can amount to as much as $43 annually, claims the maker, Hugger Products, Box 1072, Madison, Wis. 53701. Price: $23.

Smart softener

Soften your water with an electronic brain. The Lady Kenmore Cycle Miser softener from Sears monitors the use of water daily. Every 24 hours it checks its records to see if the next day is likely to be a day of heavy water use. If yes, the resin bed is replenished. Price: $700.

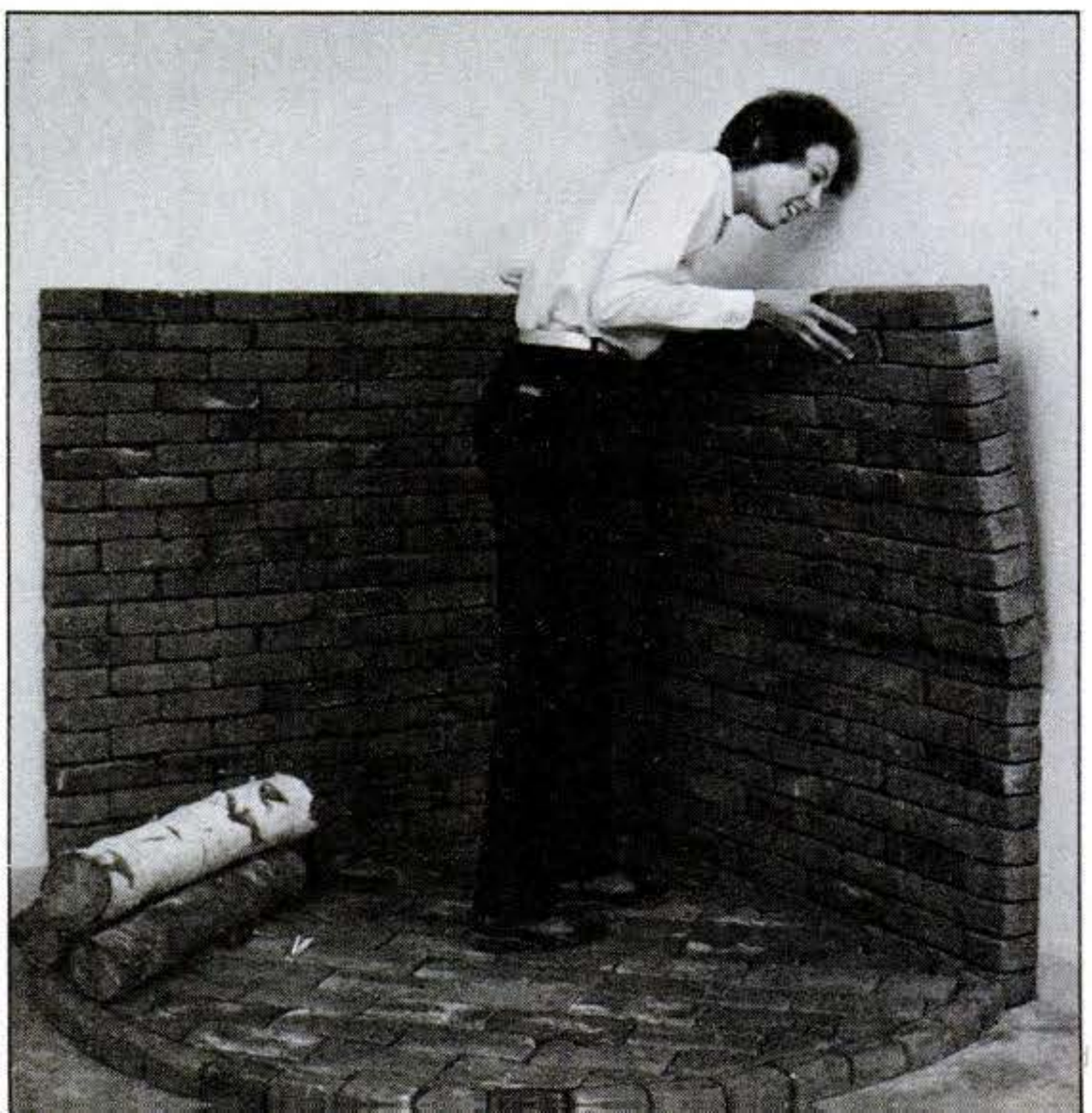


Window seal

Liquid Storm Window weatherstrips for a season, then peels off without damaging the material underneath. Once it has set, it stays flexible for an indefinite period, claims Bost Enterprises, Inc. (18 Lois St., Norwalk, Conn. 06851). Price for a bottle—enough to seal eight windows—is $7.

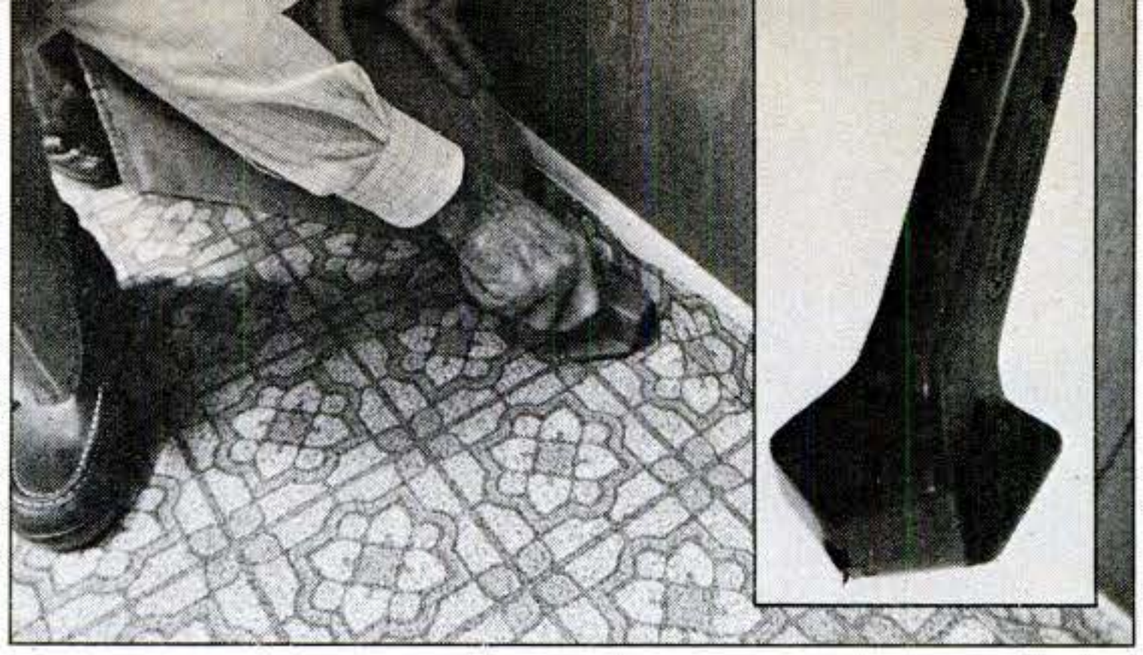
Stove backers

Insul-Brick panels for wood stoves mount flush and are lightweight, so no special hardware is needed. The panels are backed with fiberglass or phenolic foam. Price: about $7 a square foot. Aram Mfg. Co., Inc., 200 Shaw Rd., N. Branford, Conn. 06471.



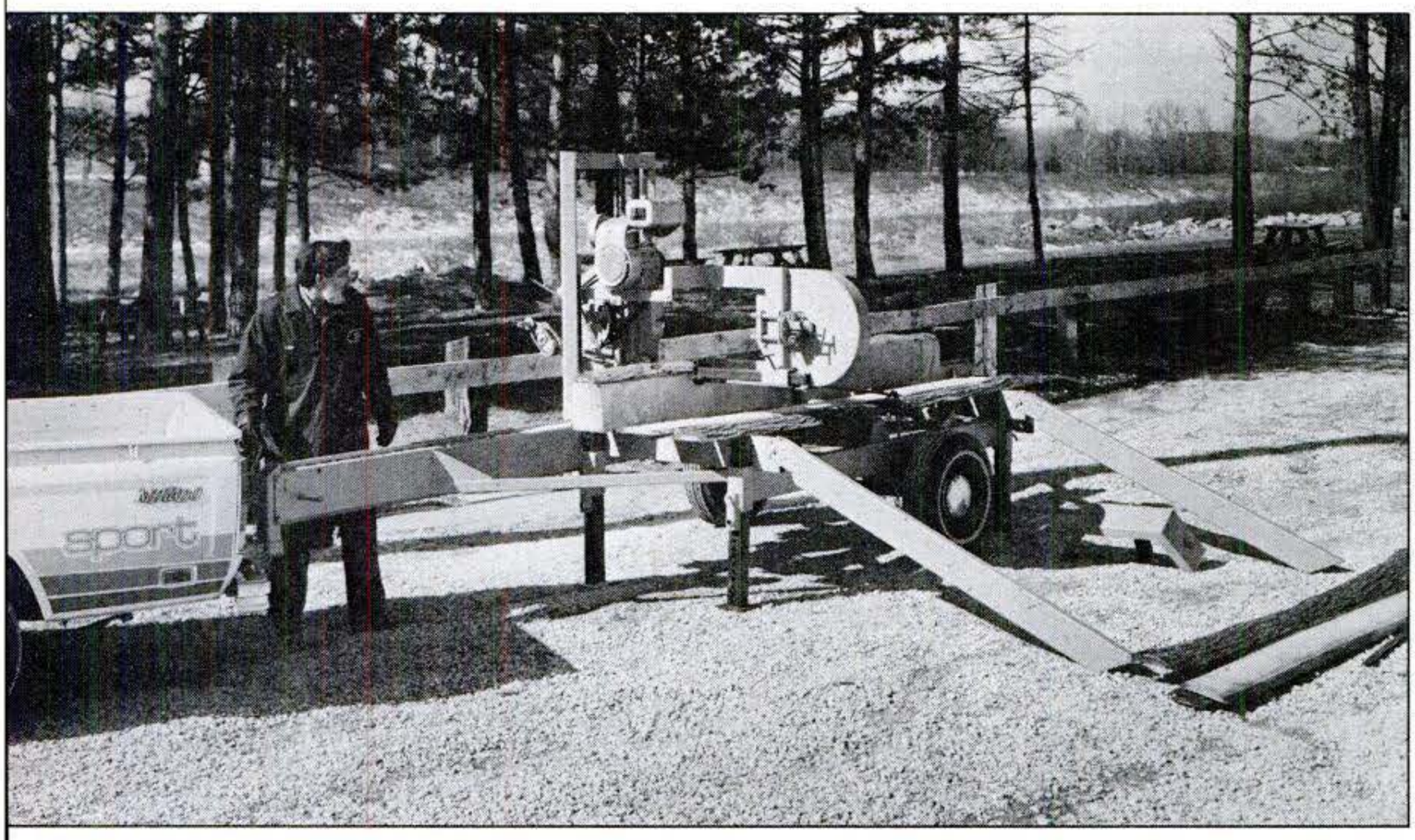
What's New IN TOOLS

BY V. ELAINE SMAY



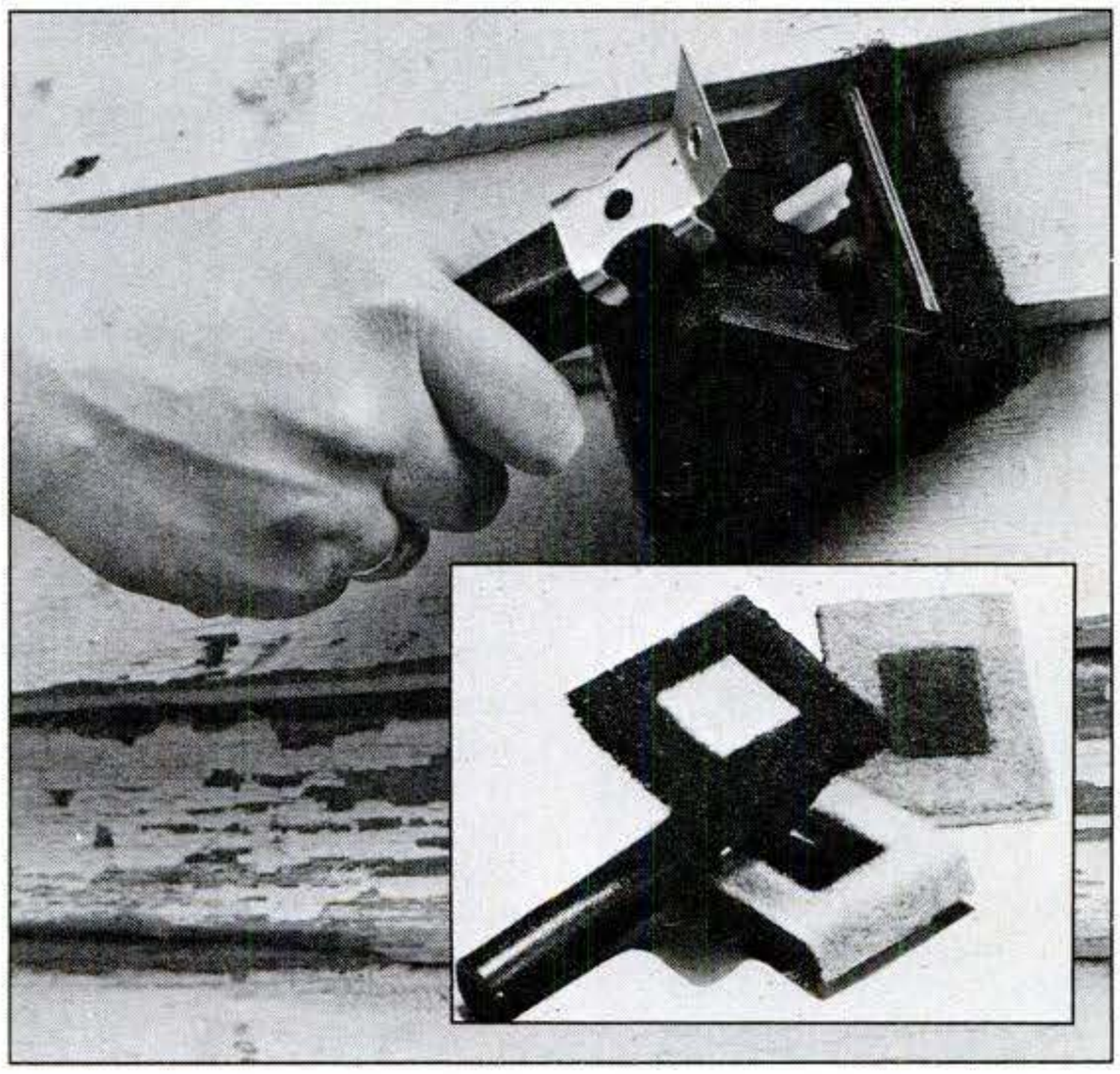
Marking pen

Fitting sheet-vinyl flooring is easy with the Accu-Marker, says Congoleum (195 Belgrove Dr., Kearny, N.J. 07032). Spread the vinyl on the floor, set the marker's adjustable tip, and trace around the room's perimeter. Accu-Marker ($5) is contoured to assure a fit.



Mill it yourself

You can turn logs into lumber with the portable Wood-Mizer band mill, says Dupli-Carver (4004 W. 10 St., Indianapolis, Ind. 46222). A band saw on a traveling carriage cuts logs up to 16½ ft. long and 2½ ft. in diameter. The mill is $3,876 (engine and trailer extra).

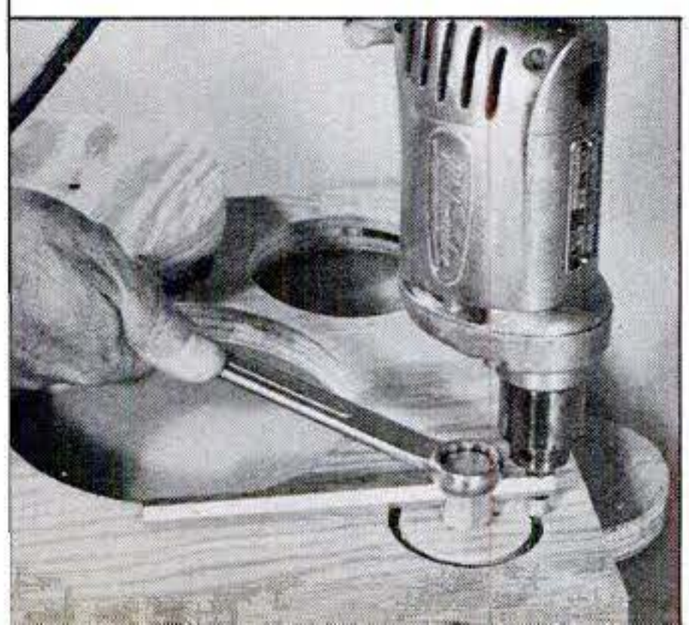


Painter's pal

A multi-use holder, the Toolex, can uncomplicate a paint job: A metal band holds the paint can on your ladder; a caddy holds brush and sundry tools. The set, $10 from Klaiber's Enterprises (601 York Rd., Fayetteville, N.C. 28303), also handles paint pads and rollers.

Repainter's pal

You'll remove old paint and grime in half the time with Quick Prep, says EZ Paintr (4051 S. Iowa Ave., Milwaukee, Wis. 53207). You dip the pad in water, which cuts drag, keeps the surface cool, and keeps the abrasive unclogged. Quick Prep is sold as kits, refills, and handles.

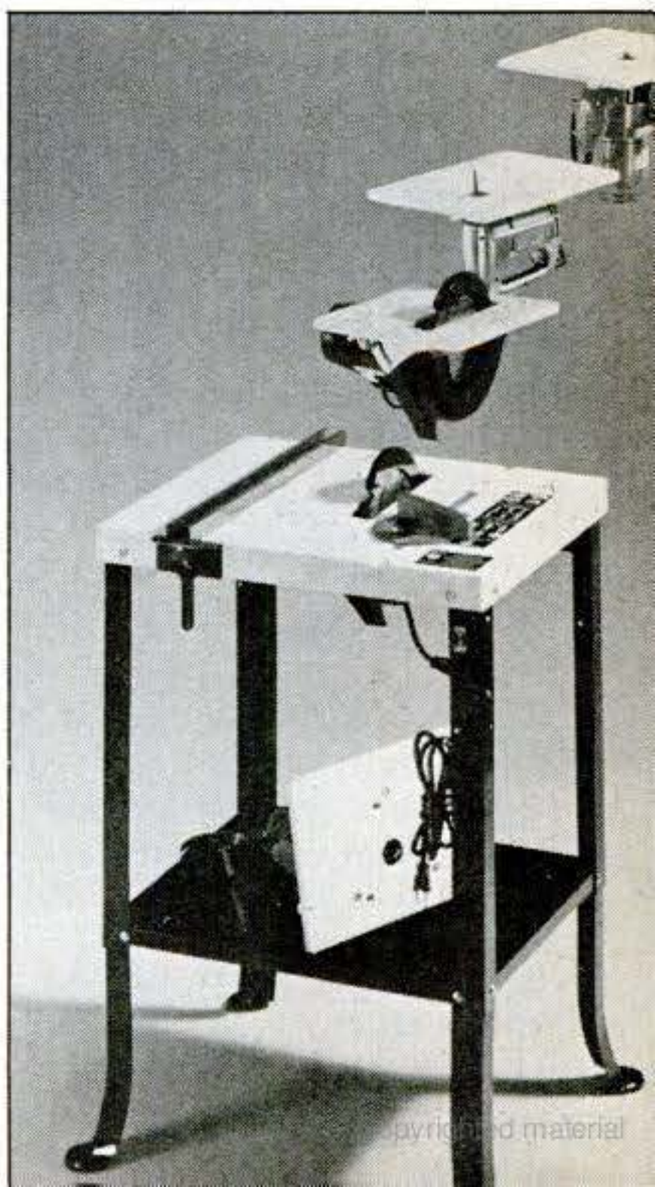


Disc cuts

Outfit your drill with the Compass Cutter ($13 from Hit Products, Box 6906, Hollywood, Fla. 33021) and it will cut 1¼- to 12-in.-diameter circles. A pivot point locks on a steel arm at the desired radius. The drill, fitted with a router bit to make the cut, is held at the arm's end.

Triple-tool table

With the Pow-R-Tool Table ($110) you can convert your portable circular saw, sabre saw, and router to stationary tools. Each tool fits on a separate panel, which slips in a hole in the tabletop. Central Quality Industries, Inc., 900 S. Division St., Polo, Ill. 61064.



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What's New IN ELECTRONICS

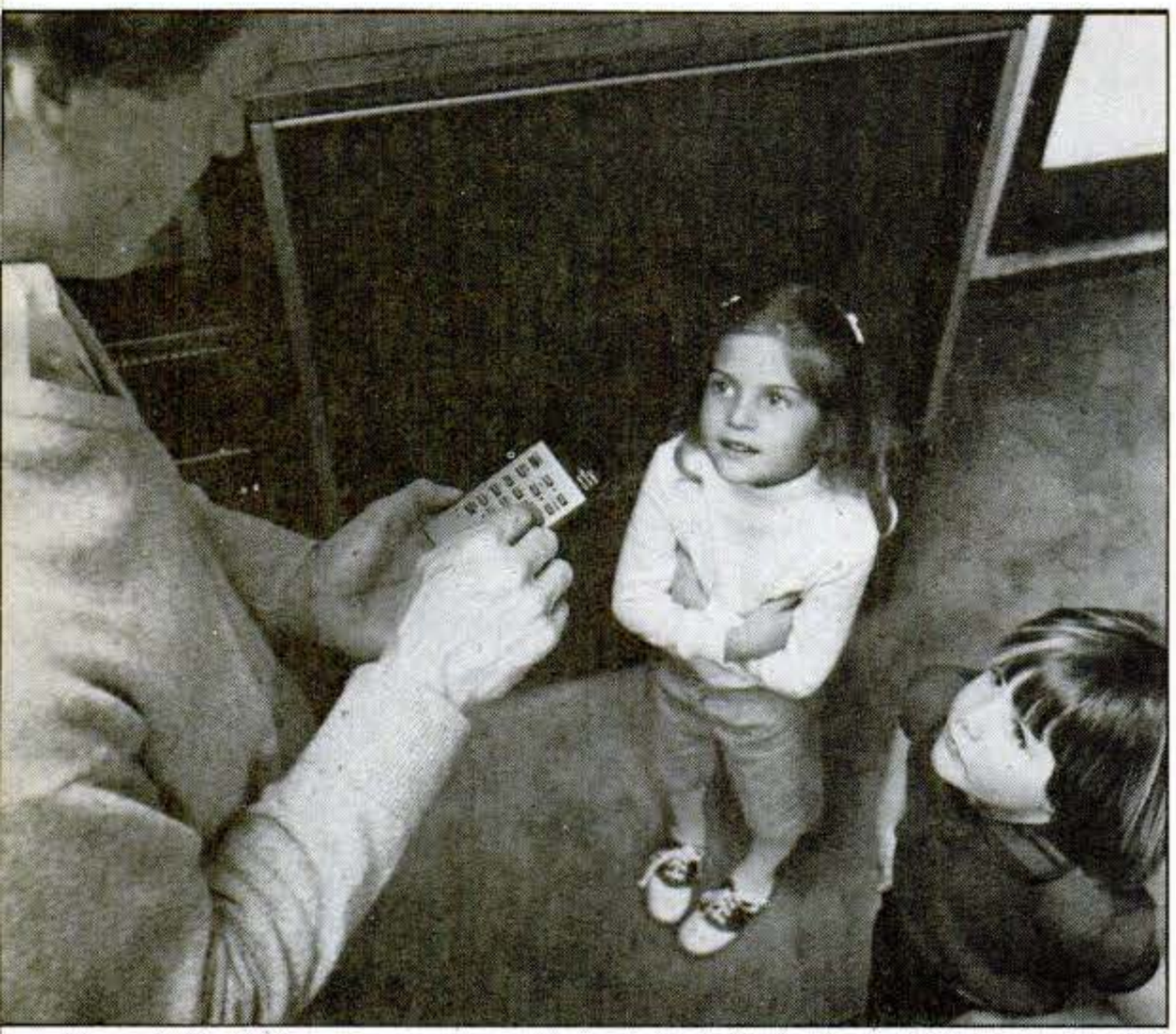
BY WILLIAM J. HAWKINS

Tote and type

Battery-powered, this Brother EP-20 electronic typewriter goes anywhere. Its display holds the last 16 characters of the line you type, allowing corrections to be made *before* it goes on paper. The five-pound unit prints on regular or thermal paper. Price: about $210.

Touch-tone add-on

Hold that box up to your phone and push its buttons—it produces tones compatible with the phone company's Touch-Tone. That means you can use Touch-Tone services (banking, shopping) without owning a Touch-Tone phone. The Duofone Tone Dialer is $35 from Radio Shack.

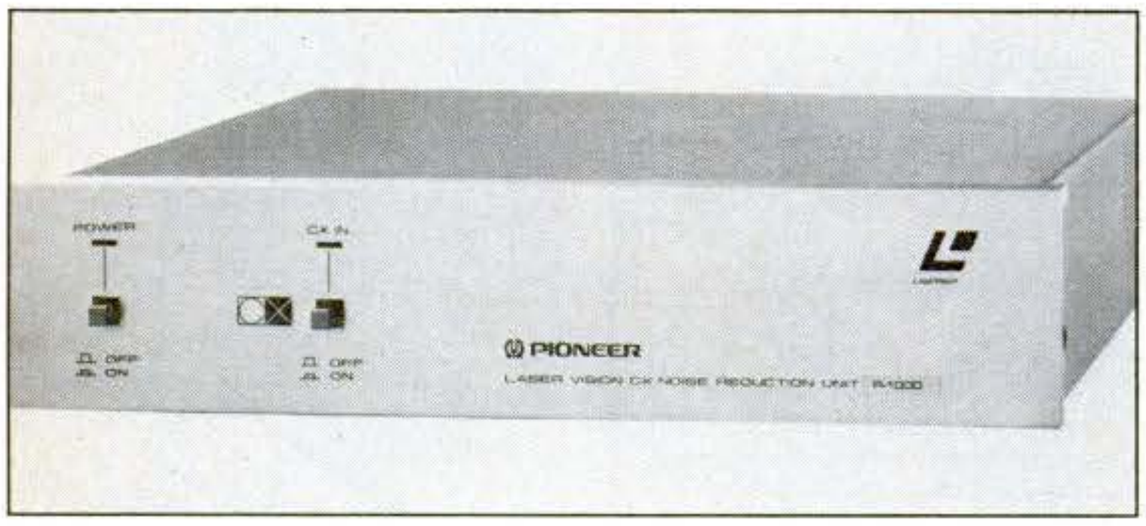


Channel blocker

Use that remote control to tap in a TV channel and any four-digit code. Result: The channel is blocked out for 12 hours or until you reenter the code—and a show that's unsuitable for kids can't be seen (there goes Howard Cosell!). It's an option on 12 new TV models from GE.

Call screener

The Fox-Fone screens your calls by answering the phone and asking callers to enter three secret numbers (using their Touch-Tones). If they don't know them—because you haven't told them in advance—the clever box hangs up. It's $160. Fox, 4518 Taylorsville Rd., Dayton, Ohio.



Hi-fi maker

Plug the Pioneer R-1000 decoder into your laser videodisc player and you hear true high-fidelity sound from any CX-encoded disc. Sound quality is comparable to the best audio record. A switchable input allows the unit to work with any brand player. It's $80.

Safe case

A fool and his money are soon parted—especially if the fool's a thief and the money is in this briefcase from Security Research (160 S.W. 12th Ave., Deerfield Beach, Fla. 33441). If moved, it transmits a radio signal, blasts a siren, and sends 2,000 volts through its handle. $1,195.

Two-way printer

In one mode, the Centronics 122 printer aims for speed, typing up to 120 characters per second. In its second mode, it produces high-quality graphics for printing charts, bar codes, and plots. It's $1,195. Centronics, Hudson, N.H. 03051.

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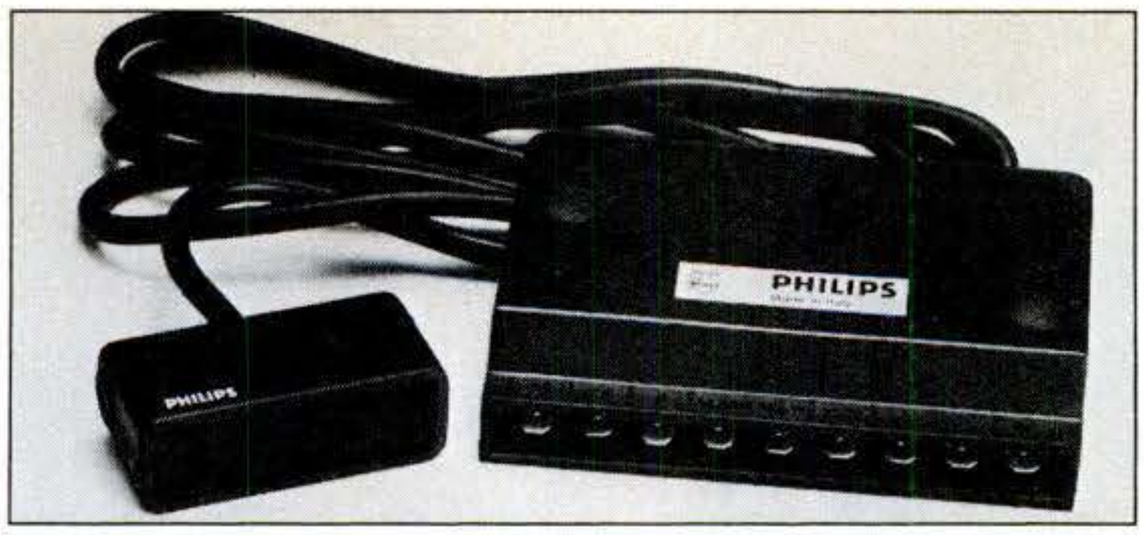
What's New FOR YOUR CAR

BY JACK KEEBLER



Ultrasonic alarm

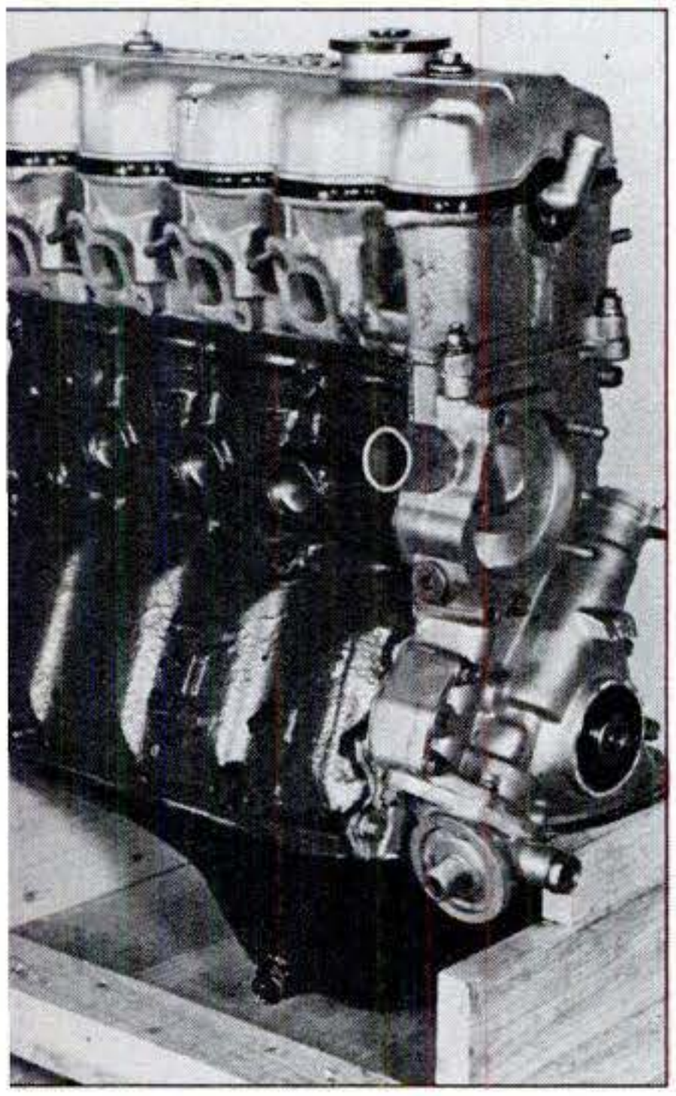
The tiny Philips alarm listens for car thieves. The air space in a vehicle is driven into vibration by its transmitter. Any change in the 39-kHz frequency, as by forced entry, triggers a continuous blast from the car's horn. Amperex, 230 Duffy Ave., Hicksville, N.Y. 11802. $179.95.

Aluminum roll bar

Now you can look smart and be safe with an aluminum-alloy 606 roll bar. House of Steel Mfg., Inc. (1155 Billy Mitchell Dr., El Cajon, Calif. 92020), claims it's half the weight of steel but comparable in strength. With hardware and instructions for assembly, it's $319.

Simple side-view

A single knob clamps this English driver's mirror to either front fender. No tools are needed. Another knob adjusts the large mirror head, which is mounted on a spring-loaded telescopic stem. Mill Accessory Group Ltd., Two Counties Mill, Eaton Bray, Dunstable LU6 2JH, England.



Japanese rebuilts

Tired Japanese imports can now be freshened up with a healthy rebuilt engine, says ATK North America (3021 S. Shannon St., Santa Ana, Calif. 92704). Covered by a 12-month, 12,000-mile warranty, the engines will include most popular makes and come as complete "long blocks."

Truck capper

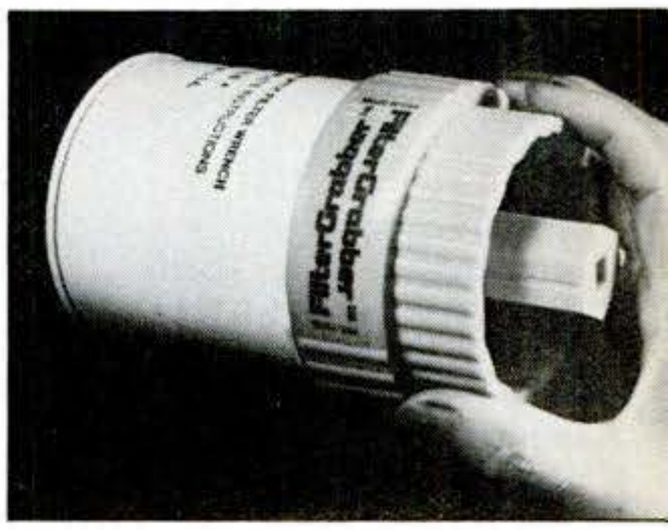
A soft cap of exterior-grade vinyl is available for Rampage and D50/Arrow pickups. It features a five-window design with Velcro fasteners for easy access. Price: $272.75; Direct Connection Catalog Center, 20026 Progress Dr., Strongsville, Ohio 44136.

Medi-key chain

You won't leave home in your car without needed medication when you use this key chain. The maker (Joseph Liebman, Box 3154, Hialeah, Fla. 33013) says the FDA-approved polypropylene case keeps prescriptions dry and sanitary. The top holds important medical information. $2.99.

Filter wrench

FilterGrabber makes changing your oil filter easier, claims Normark/Handi-Products (Box 400408, Dallas, Tex. 75240). Made of Du Pont Zytel to resist oil, it's reversible to fit large and small filters, and can be turned with a box wrench or ⅜-in. ratchet handle. Price: $6.95.



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4-wheel drives for '83

—smaller, but still rugged

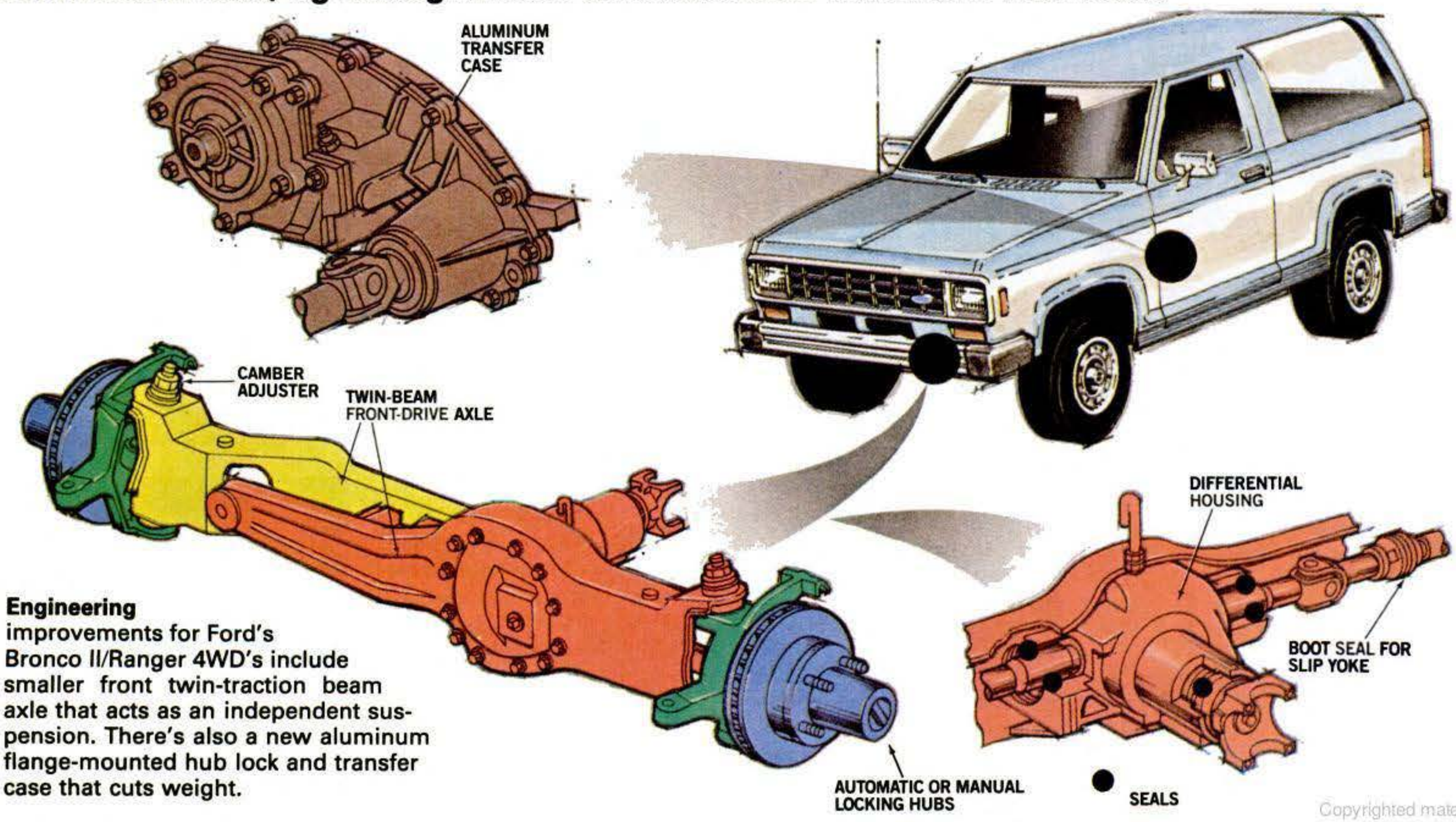
Ford Ranger 4WD pickup has new five-speed manual transmission, diesel-engine option, and trimmer dimensions. It has computer-designed front and rear springs and computer-set front-end alignment. Wind-tunnel testing improved aerodynamics.

Detroit takes aim at the Japanese off-road models—and comes up with some formidable competitors

By HERBERT SHULDINER
ILLUSTRATIONS BY RUSSELL VON SAUERS

The seven-mile loop wound through the Suntan Mountains, near Mesa, Ariz. Huge rocks, deep potholes, and steep climbs and descents made it the toughest off-road course I had ever encountered. But it was made to order for testing Chevrolet's 1983 four-wheel-drive Blazer and S-10 pickup. The Chevrolet four-wheel drives, along with AMC's XJ due out next year (see "Detroit Report") and Ford's new Ranger 4WD pickup and Bronco II, introduce a

From Ford: new, lightweight front-drive axle and aluminum hub locks



Engineering improvements for Ford's Bronco II/Ranger 4WD's include smaller front twin-traction beam axle that acts as an independent suspension. There's also a new aluminum flange-mounted hub lock and transfer case that cuts weight.

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new generation of smaller utility vehicles designed to compete head-on with Japanese imports. The new smaller domestics are brawnier than the imports and are capable of the same rugged performance as their bigger predecessors. The '83 Ford and Chevrolet four-wheel drives are also loaded with engineering innovations. And lightweight materials cut weight, improve economy, and provide better ride and handling.

The Chevrolets I tested impressed me with a surprising degree of ride comfort on and off the highway. In fact, the shorter Blazer displayed less pitch than the bigger '82 model. Much of that is due to a new independent suspension. "We tailored the ride-rate characteristics of the suspension to provide the right pitch control for a vehicle of this type," says Brook Lindbert, a senior development engineer for Chevrolet. The independent suspension gives you more wheel travel than the old solid-axle system, Lindbert says.

Also new for the '83 Chevrolet four-wheel drives is a patented center differential (see illustration) used to distribute power to front and rear differentials. Similar to the one on the AMC Eagle, it allows you to shift from 2-High to 4-High at any speed without stopping. I did it on the highway while traveling 55 mph and on the off-road course at lower speeds. The maneuver is virtually effortless. When you shift into 4-Low, however, the vehicle has to be stopped because the transfer case isn't synchronized.

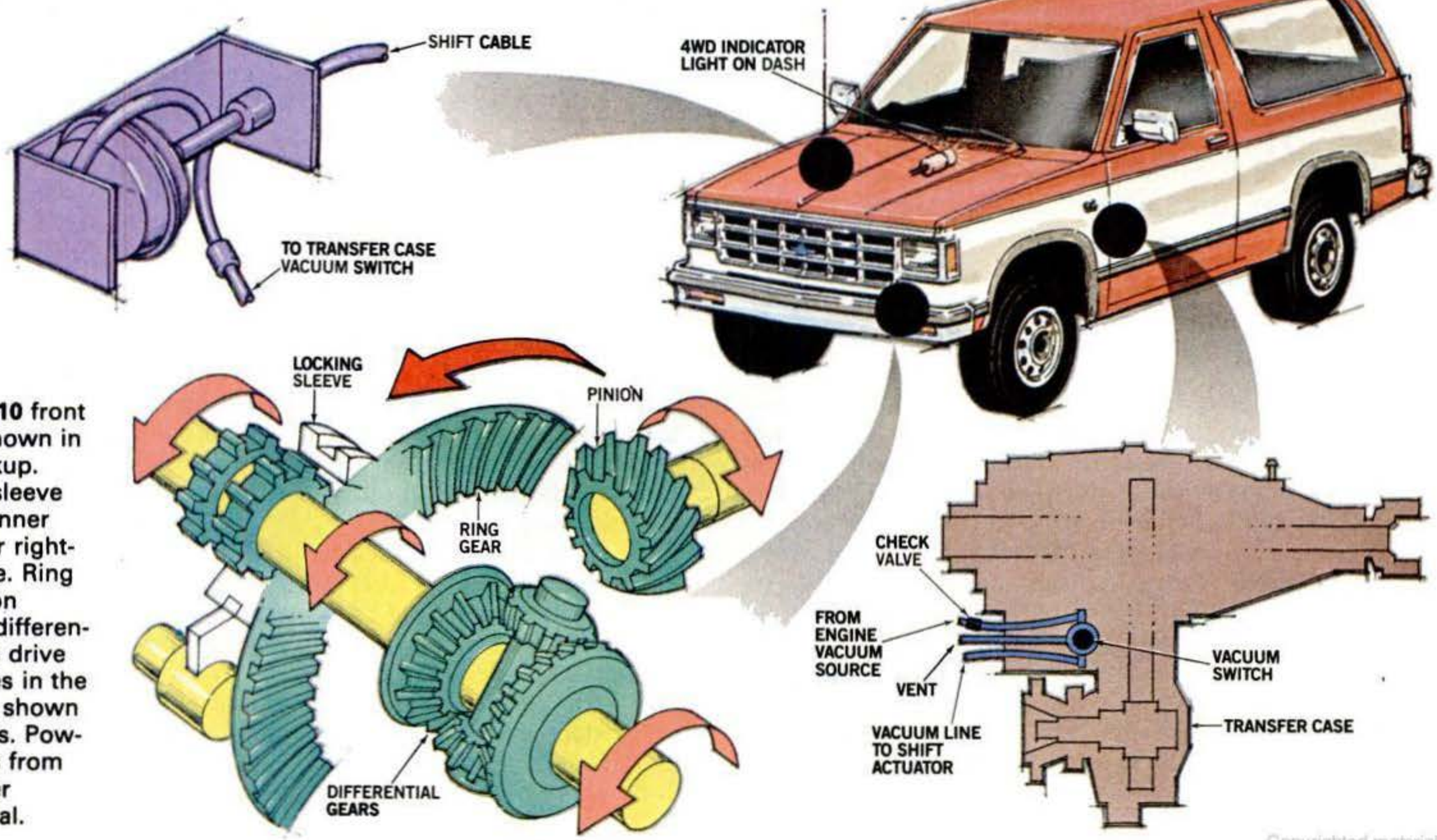
Ford's four-wheel drives feature a new weight-saving front axle with an aluminum flange-mounted hub-lock design. It saves about 14 pounds over the old steel hub-and-rotor assembly, says Scott Channell, a Ford engineer.

The new Ford off-road models can be shifted into and out of 4-High while you're cruising, once the hub locks are manually engaged, says George Manning, a Ford design engineer. Additional improvements have been made to the front-axle seal, Manning says.

The two-wheel-drive Ranger and S-10 were among the bright spots of Detroit's dismal 1982-model sales year. The four-wheel-drive versions of the pickups and the new Blazer and Bronco II may well be the success story of '83. ■

S-10 4WD pickup (foreground) and Blazer give Chevrolet an all-new off-road lineup for '83. Though smaller, Blazer actually offers more flat cargo area when seats are folded than the bigger '82 model. Independent suspension gives a comfortable ride.

Chevy's center differential gets you into 4WD at any speed



Blazer/S-10 front axle is shown in 4WD lockup. Locking sleeve couples inner and outer right-hand axle. Ring and pinion through differential gears drive both axles in the direction shown by arrows. Power comes from the center differential.

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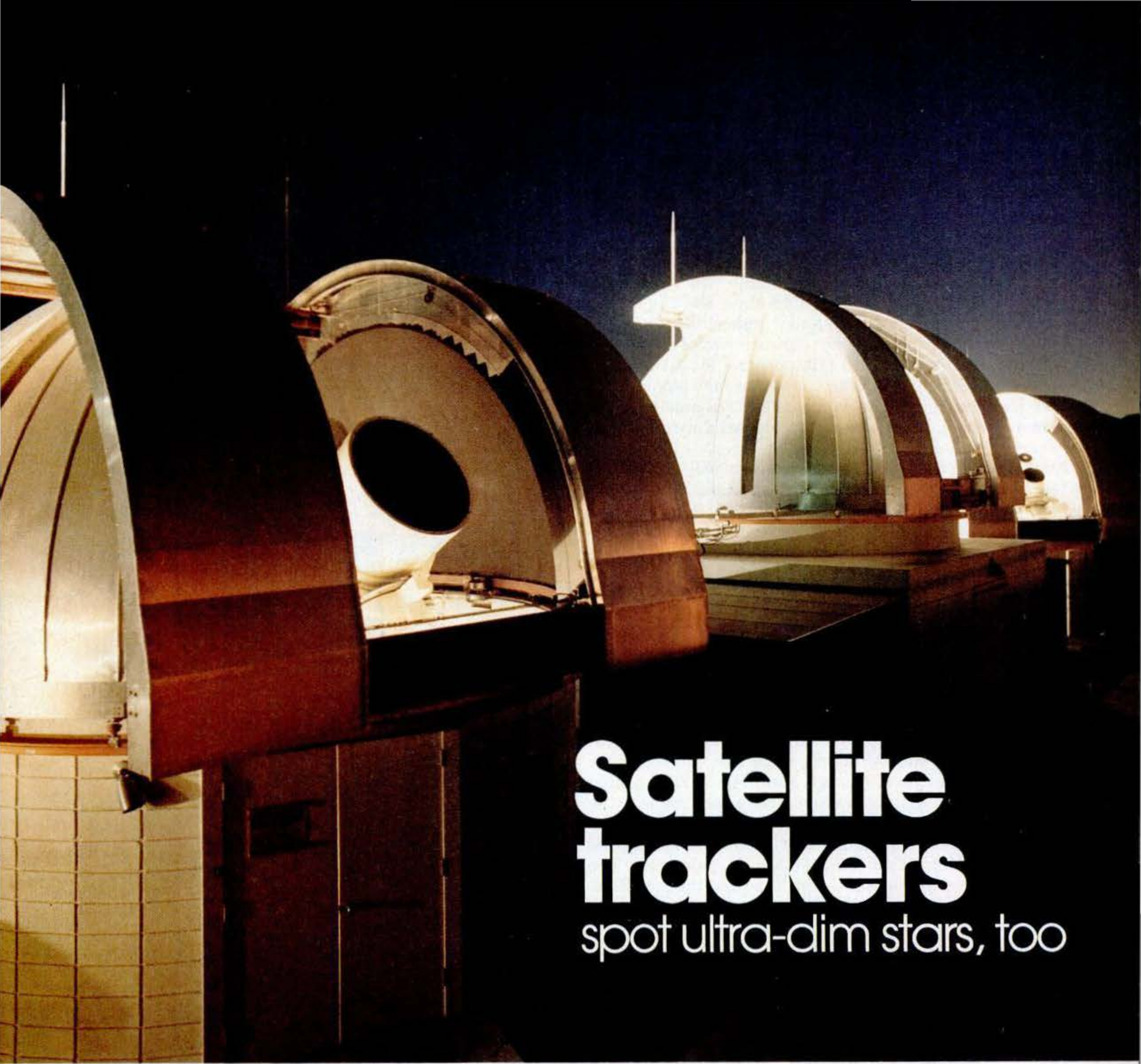

Satellite trackers

spot ultra-dim stars, too

Getting a sharp fix on what's in orbit requires canceling out some fascinating deep-space data

By JIM SCHEFTER
PHOTOS BY ED McCROSSAN

The site looks like any small mountaintop observatory, with white-turreted buildings housing instruments to study the stars. But this one, in a remote corner of White Sands Missile Range, near Socorro, N.M., is different.

Using unique folded optics in three super-sensitive telescopes, this observatory records video images of millions of uncataloged stars each clear night. Then it erases them.

The mission for this startling new system, which may be one of the most sensitive astronomical tools ever developed, is not astronomy. The system is a satellite tracker, designed for the U.S. Air Force to locate and track objects in high orbits around the Earth.

Called GEODSS, for Ground-based Electro-Optical Deep Space Surveillance, this new system is so discriminating it can spot and track an object the size of a golf ball 3,000 miles away. At 22,000 miles up, it can find pieces of potentially hazardous debris just 12 inches across as easily as it tracks the far larger geostationary communications and weather satellites operating at that altitude.

Five of these superior new observatories are planned, replacing the Baker-Nunn cameras that have tracked satellites and debris for the North American Aerospace Defense Command (NORAD) for more than 20 years. Installations in White Sands, Korea, and Hawaii will all be operational this year. Equipment will be installed on Diego Garcia in the Indian Ocean, and at another site yet to be selected, in 1985.

The advanced tracking system is needed, says Air Force program director Col. Richard Donovan, because "the complexity of tracking becomes greater as the satellite population increases." The number of objects in orbit—satellites and debris—now ranges upward of 10,000 [PS, July]. But the same qualities that suit GEODSS for tracking—extreme sensitivity and wide-angle imaging—also make it ideal for astronomical sky surveys, and that has created an

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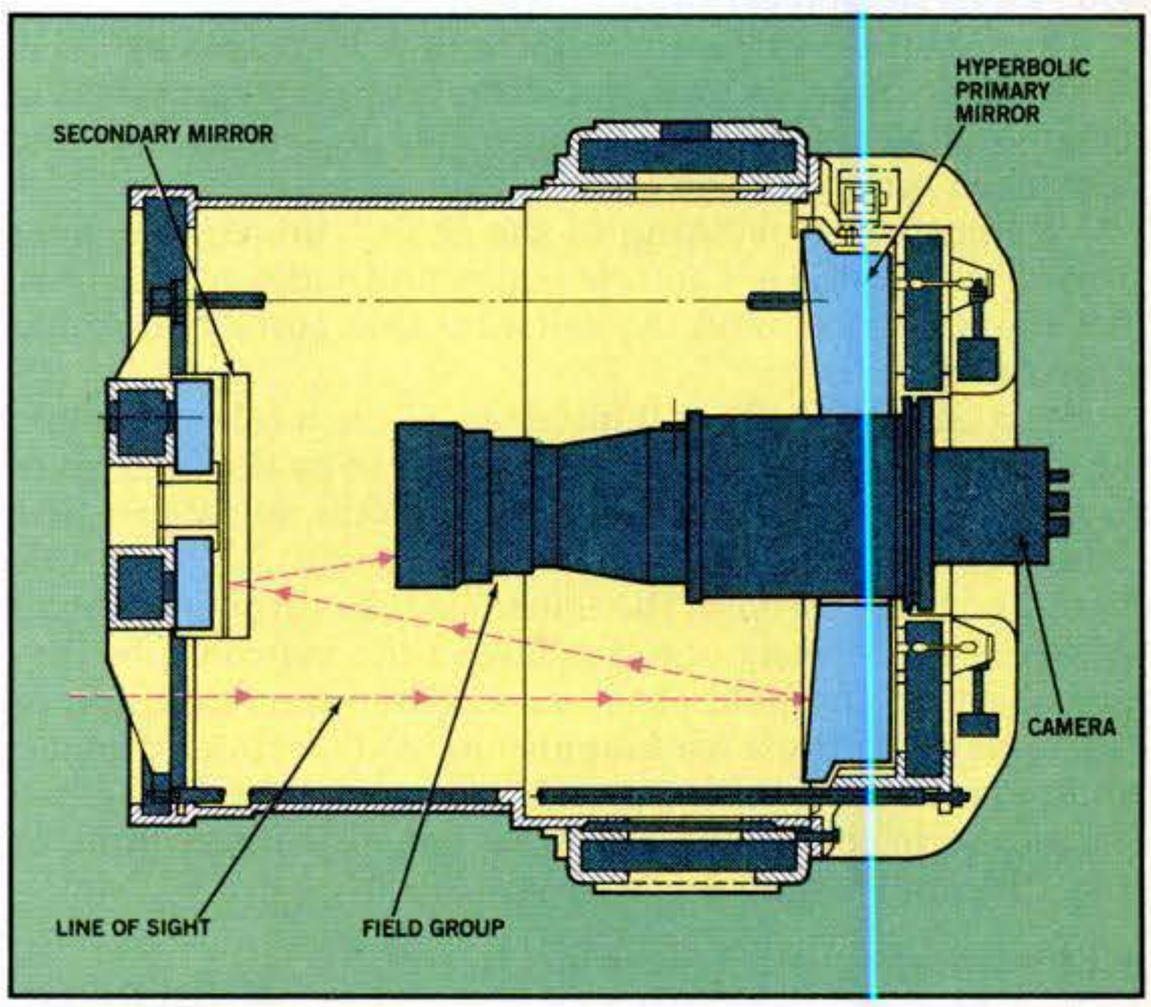

Satellite-sleuthing trio at White Sands Missile Range (facing page) is one of five observatories in worldwide network that will watch out for surprises in orbit. North American Aerospace Defense Command now tracks only about half the objects—satellites and debris—in region of space between 3,000 and 20,000 miles up, and its present photographic sensing system causes delays. Electro-optical GEODSS system will detect whatever is there and display it instantly at site control room (top) and at NORAD headquarters. Photo (left) and drawing (above) show design of main GEODSS telescope. Light travels length of telescope tube, reflects forward off precisely ground hyperbolic mirror, then strikes a flat secondary mirror just behind aperture. That mirror reflects light back through field-correcting refracting lenses, which focus image onto face of vidicon tube. Mirrors are counterbalanced to prevent gravity-induced distortion.

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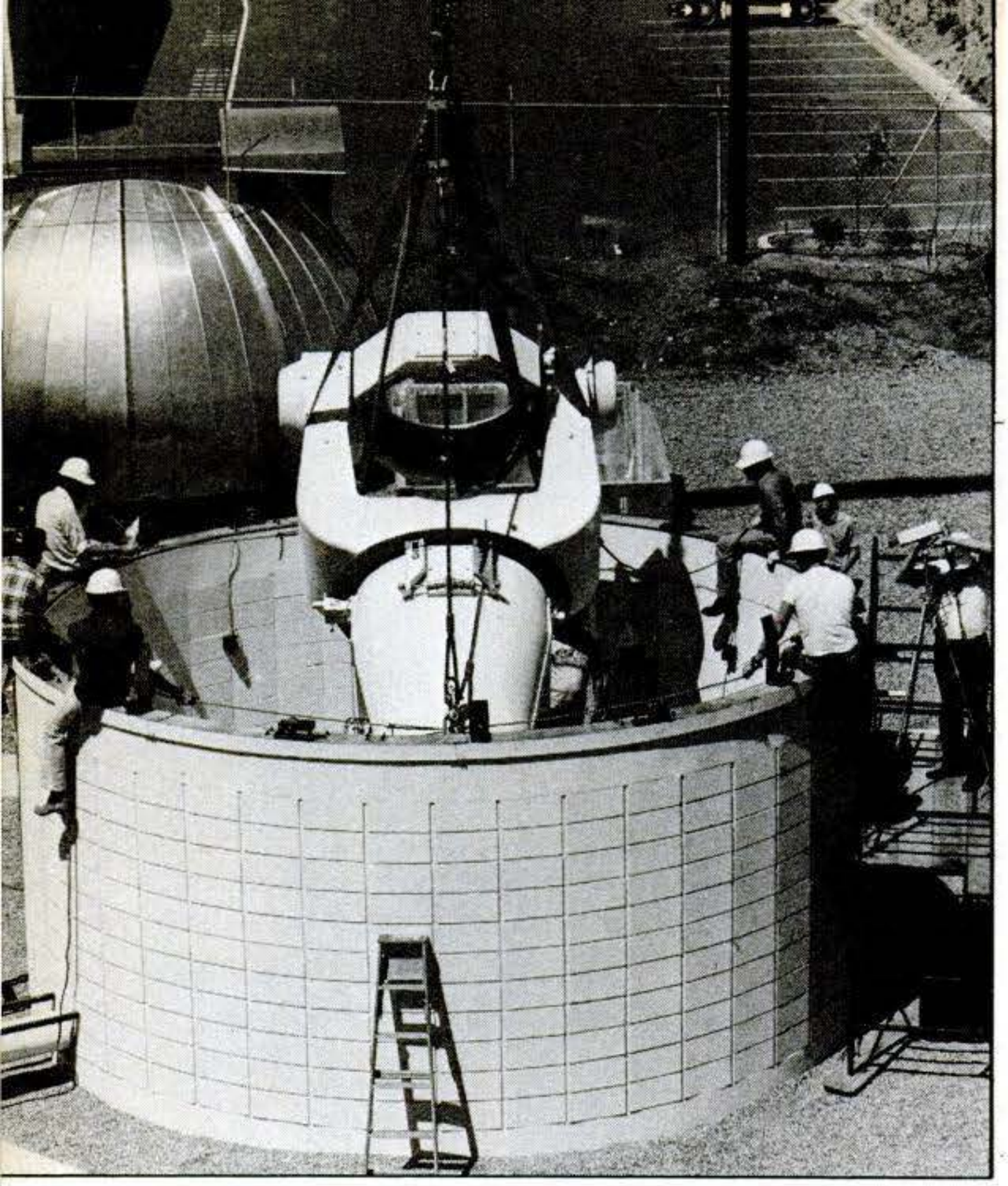

Sixteen tons of sophisticated optical and electronic equipment are installed in observatory dome at White Sands. The New Mexico GEODSS site began its night surveillance duty last May.

unusual dilemma for the Air Force. Much to the dismay of astronomers, the system is actually dumping star data. But more on that later.

The GEODSS system, designed and developed by TRW in Redondo Beach, Calif., is a state-of-the-art combination of unique optics, equally unique vidicon technology, and advanced computer software.

"We pushed everything to the limit," project manager David Otten said. "The telescopes and vidicon tubes are both new designs, and the software that sorts everything out is terrific."

Each GEODSS site will have two 40-inch telescopes and an auxiliary 15-incher, all manufactured by the Contraves Goerz Co. of Pittsburgh, Pa. The main telescopes use folded optics to get an 86-inch focal length. Light travels back and forth through the telescope tube (drawing), finally focusing precisely onto the face of the vidicon tube. Every object in the field of view—whether star, satellite, or junk—down to the 17th magnitude (25,000 times dimmer than can be seen with the naked eye) is recorded. When atmospheric conditions are excellent, objects as faint as the 19th magnitude are visible.

Silicon heart, programmed brain

The device has a two-degree field of view, considerably larger than that of typical astronomical telescopes, and weighs just 3,200 pounds. Under computer control, it can be moved rapidly—two degrees in one second—to examine new parts of the sky, and can be stopped within 1.5 arc seconds of the desired angle. The smaller auxiliary telescope has a six-degree field of view and a 30-inch folded-optic focal length. Its mission is to detect and track brighter objects at higher search rates.

The heart of the video system is an RCA-developed "silicon intensified target" vidicon tube with a large, three-inch aperture that records extremely low light levels. This is installed in an Itek camera that has a 2:1 electronic zoom and a scan rate of either 0.3 or 0.6 second per frame. With the slower scan rate and high zoom, it can spot very dim, slow-moving objects in orbit.

More than 400,000 lines of software had to be written to give the tracking system its full capabilities. "Without the software, GEODSS wouldn't work," Otten said.

The software controls telescope movement, automatically adjusts light-control settings and camera operation, and examines digital data to separate stars from moving objects. It also includes catalogs of known stars and orbiting objects.

Every sequence starts with an exposure to map the field of stars, perhaps 20,000 in a single frame, and the orbiting objects being tracked. The brightness and motion data on every spot are digitized and instantly examined by the system's computer.

Through the magic of software, the computer then erases every object that is in its catalog of known stars and everything that isn't moving. What's left is "noise" and orbiting objects. Comparisons of four or five frames of the same sector allow the computer to erase the noise and leave only a digital record—brightness, speed, and direction of travel—of a satellite or debris.

Once a moving object is isolated, the computer compares it with its catalog of known objects, identifies it, if possible, and updates its orbit. If the object is new, it assigns a number to it. The results are automatically transmitted to NORAD's control center beneath Cheyenne Mountain in Colorado. (With the Baker-Nunn cameras, film has to be developed and analyzed before NORAD gets updates.)

One GEODSS site, staffed by about seven people, can search up to 7,400 square degrees of sky per hour, Donovan said. In a typical night of work, a site should collect orbital data on about 200 objects.

"Most of the system's mission will be to regularly update the NORAD catalog of space objects," TRW's Otten said. "My belief is that we'll find everything that's up there."

But it will also find stars, better in some ways than any available astronomical instruments. The fact that it promptly erases those images nettles some astronomers.

"It's like spilling the star data on the floor," said Professor Bruce Margon, chairman of the University of Washington astronomy department. "But you could trap and retain 100 percent of the star information. Nobody has ever had a system that records the brightness of all those stars."

The world's largest star catalog, at Harvard University, has photographic records of about 750,000 stars down to the 14th magnitude. Some of those photographs are nearly a century old and difficult to interpret. Some stars, Margon said, appear only in six or seven frames taken over a 100-year period.

GEODSS will measure six million stars an hour, recording data on every star in view twice a night.

Margon has proposed a piggyback recording system that would save the star data on laser-written videodiscs. "We could get a permanent, ongoing digital record of the brightness of every single star down to about the 17th magnitude," Margon said. That detailed information would be crucial to astronomers studying stellar objects—quasars, novas, X-ray bursters, and others—that flare up in the future.

"The problems we could tackle span the entire range of astronomy—structure and evolution of stars, cosmology, you name it," Margon said.

Margon's proposal is being evaluated by several government and private agencies. The Air Force, meantime, is keeping the astronomy community at arm's length, awaiting word on whether the data-storage system will get necessary funds. In the official view, GEODSS tracks satellites, not stars.

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The glass-wired community

Experimental fiber-optic loops link rural Canadians to phones, TV, computers

By MORT LA BRECQUE

ELIE, MANITOBA

Here, 30 miles west of Winnipeg, I watched as:

- A farmer entered an order on a keyboard that brought the latest grain prices flashing onto a TV-like monitor.
- A school trustee tapped her keyboard to find out whether local road and weather conditions warranted closing school.
- A schoolgirl signed on to a computer that had been teaching her intermediate algebra.

What's happening in the partly French-speaking farm communities of Elie and nearby St. Eustache is a preview of the glass-wired system that will eventually link people everywhere to a wide variety of information and entertainment sources by cables made of hair-thin optical fibers. The 18-month trial, costing $9.5 million and involving 150 subscribers, will determine whether their use justifies making these services more widely available. And it will tell whether fiber-optic cables can stand up to 80-degree-F summers and 40-below winters—both above and below ground.

"The ground gets frozen five or six feet deep in the winter," explained Kenneth Harris of Canadian Telecommunications Carriers Assn. (CTCA), one of five sponsors. "In the spring, as the frost comes out it causes the ground to heave. This movement will exert strong pressure on the cables, which can cause transmission losses."

Why Elie and St. Eustache?

The experiment began with the Department of Communication's concern about rural isolation. Many Canadians live in sparsely populated, remote areas where they need telecommunications services even more than city dwellers. Yet because they are so much farther from telephone centers, rural subscribers must settle for multi-party lines to keep down costs.

When the Department of Communications joined with Manitoba Telephone System, Northern Telecom, CTCA, and Infomart, it had a choice of two delivery systems. The more conventional one combined copper pairs for the phone service with coaxial cable for the others. But optic fibers proved cheaper because they offered many more channels, on a single cable that was strong as steel and flexible as plastic.

"Our standard fiber cable, which has 12 fibers in it, is only an inch or so in diameter," Anthony Wilson of Northern Telecom told me. "Since each fiber can carry more than 600 phone channels, the cable can carry more than 7,200 channels or 3,600 conversations. A coaxial cable that could carry that number of conversations would be very much larger and heavier—and considerably more expensive."

Fibers also need fewer repeaters to amplify the signal than do coaxial cables, Wilson pointed out, since there is less signal loss with optical transmission. Yet another advantage of fibers is their immunity to electromagnetic interference, which plagues coaxial cables placed in the same corridor with power lines.

I visited Elie five months after the experiment began. George Tough of Manitoba Telephone showed me around the Field Trial Center, a trailer stationed near Elie's telephone switching office. It contains a demonstration area and a central switching unit that connects outside services to subscribers' phone lines.

How it works

"Canadian TV channels and FM-radio channels are received from Winnipeg by an antenna here at the Center," Tough said. "American TV channels are tapped off the inter-city broad-band network, a video trunk line to Winnipeg and other Manitoba cities. The videotex signals also come in from Winnipeg where the computers are, but via a separate data trunk line."

In the trailer, a line interface unit for each subscriber combines the four incoming signals into a single broadband signal in a kind of multiplexing operation: Telephone and data are carried below five megahertz, FM between 23 and 27 MHz, TV at 7.6 and 55.25 MHz.

The combined signal then modulates a light beam emitted by a laser or a light-emitting diode in the interface unit. (The laser serves subscribers who have two TV's or live farthest from the center.) The line interface unit also contains a photodiode that converts the optical beam from the subscriber into an electronic signal for de-multiplexing into separate telephone-voice, data, and TV control signals.

Cables leave the center with 36 fibers, but this number decreases as fibers drop off at subscribers' homes. Each home gets three: one for signals

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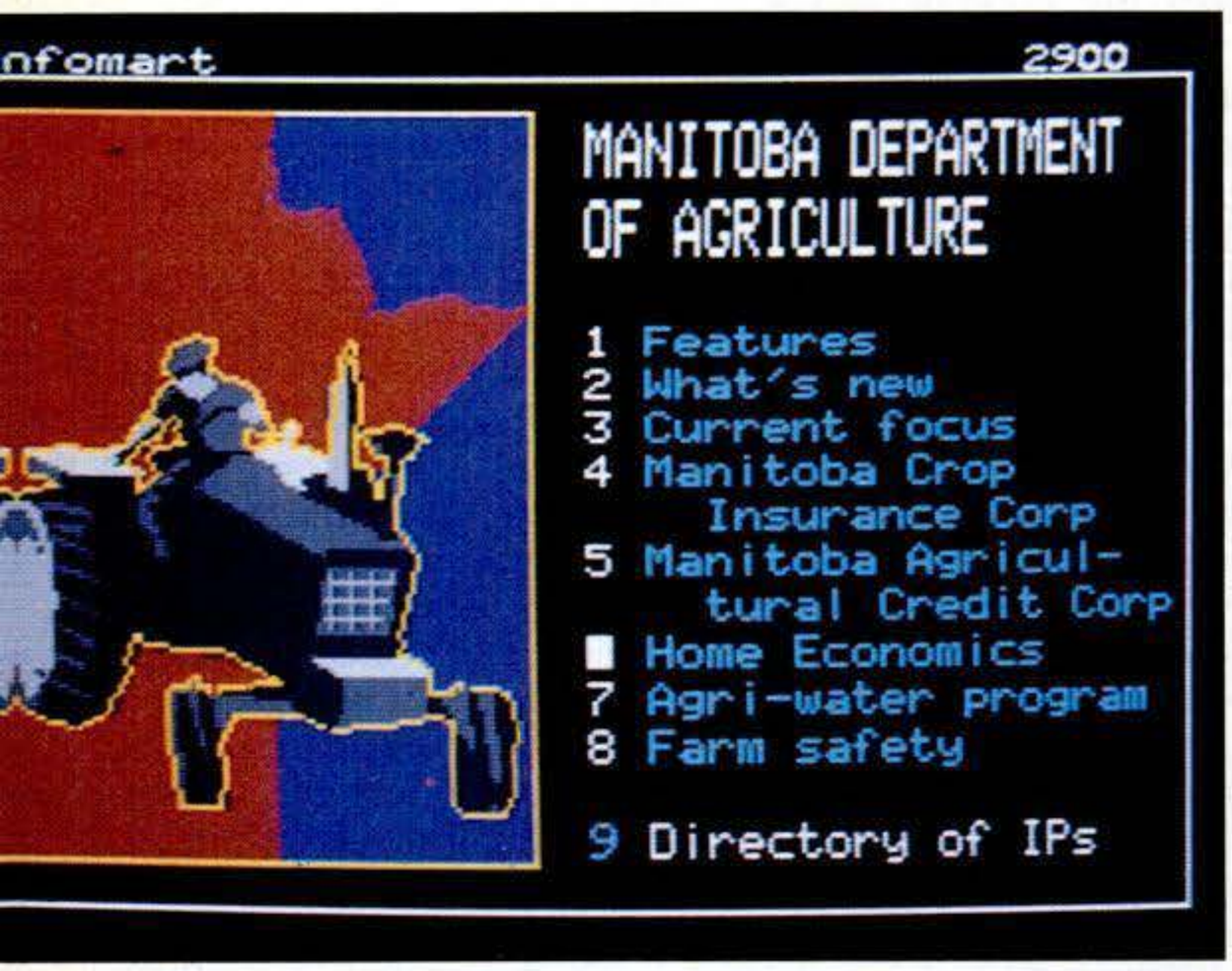
Telephone developed for the experiment transmitted over optical fibers like these, each able to carry more than 600 channels.

Fiber-optic phone lines also link distant computers to home TV sets



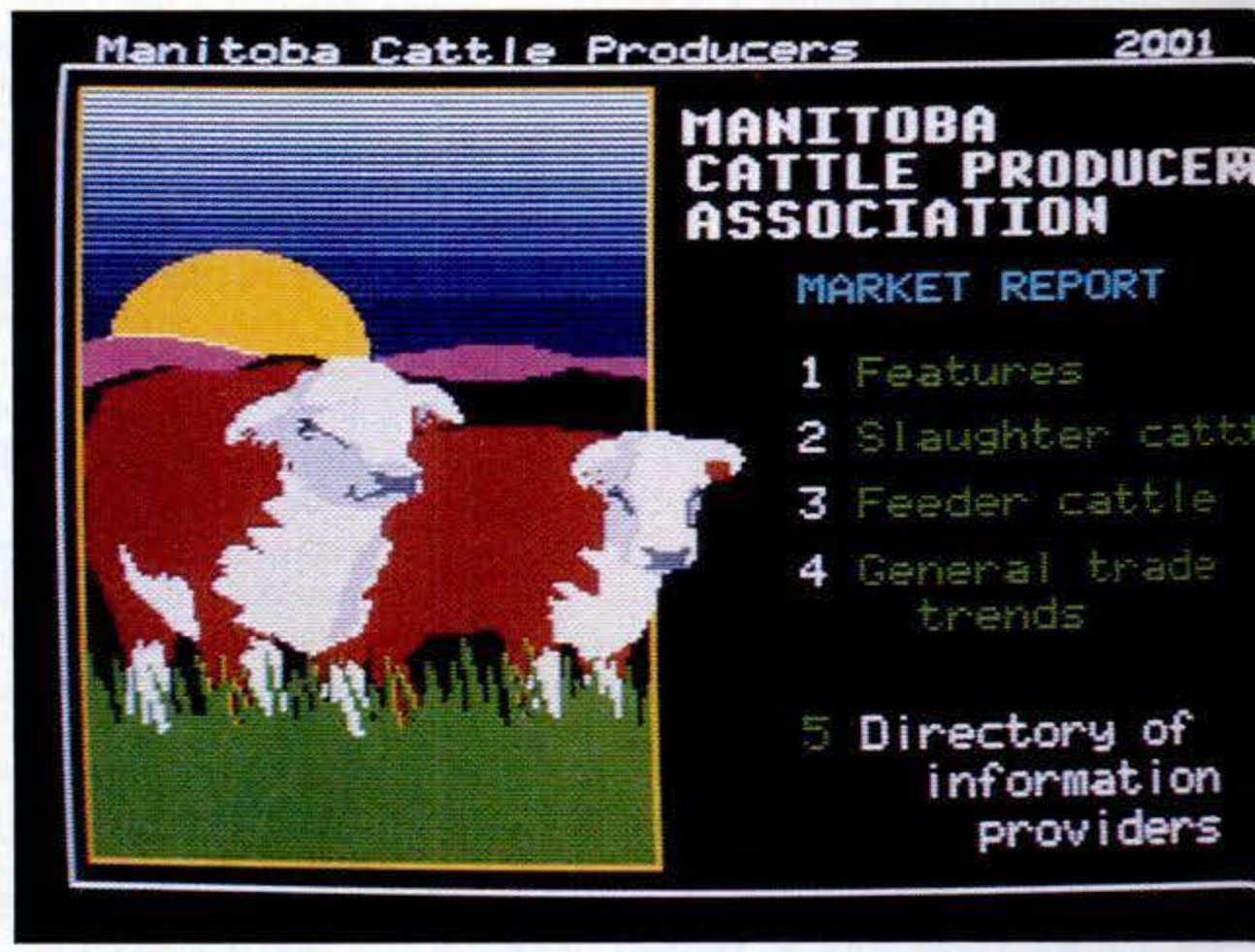


Table of contents pages show two of the many subjects stored in the computer for viewing on demand. Using Telidon, an electronic video alternative to print and broadcast media, Infomart offers nine topics supplied to its grass-roots data base by Manitoba's agriculture department and five topics from the cattle producers' association. Subscriber punches the number of the topic he's interested in and computer displays it. Other computer-supplied services include news, weather, reports from commodity exchanges, airline and sports schedules, childrens' stories, academic instruction, even winning lottery numbers.

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Satellite weather forecast, with map in color, appears on Hilda Martens' TV at the touch of a few keys. Computer updates the predictions three times a day.

to the home, one for those *from* the home, and one spare. In several cases, both upstream and downstream signals travel over the same fiber—at slightly different wavelengths. In these tests of bidirectional use, the other two fibers act as spares.

To avoid using repeaters, loops are no longer than six miles. Since this restricts the Center's reach to houses within three miles, a second distribution center was set up in St. Eustache and connected to the main one in Elie by a five-mile-long optical line.

Subscribers' homes have entrance units like the interface units at the Center. In these, the photodiode receives the incoming optical beam and the light-emitting diode sends a beam back to the Center. Inside the house, ordinary electrical wiring carries the separated signals, now in electronic form, to the appropriate telephone, TV, FM, and videotex terminals.

The only problem that's emerged so far is that some of these subscriber entrance units—30 to be exact—have failed. George Tough attributes this unexpectedly high number to inadequate grounding of all equipment in older homes. He expects the situation to be corrected easily in future installations.

They like it

The customers I spoke with in Elie and St. Eustache clearly want the new services to continue. Single-party telephone lines alone have been a boon to them. Hilda Martens, a housewife and school trustee, had a party line before the trial. "I was on the same line as the community club, the convent, and the school," she said. "You heard the phone ringing constantly. I only got to use it if I was lucky."

Now Mrs. Martens discusses school business whenever she likes. "So much of it is private information," she explained, "that you can't take a chance of somebody listening in."

Vic Beaudin, who runs a large grain farm, conducts a lot of business over the phone—which he used to share with five other subscribers.

Neither of these families listens to FM radio, but both appreciate cable TV. Not only is reception of Canadian channels picture-perfect, now they get four U.S. channels, as well, all without using rooftop antennas.

But their strongest response has been to videotex, a kind of electronic publishing that lets people directly retrieve text or graphics from remote computers. Videotex has several advantages over print and broadcast media, according to Leigh Sigurdson of Infomart, a videotex supplier.

"The system is always kept up to date," said Sigurdson. "It's ready any time you are. And all the information you need is in one place."

To use Telidon, the Canadian version of European-developed videotex, a subscriber phones the computer. If it recognizes his authorization code, the computer prints on his TV screen a list of all the categories in its data base. The customer punches up on his keyboard or key pad the category he wants—say, news. A second listing then replaces the first, breaking down news into local, national, and international. Some more taps on the keyboard and the kind of news wanted appears.

By far the most popular services, Sigurdson told me, are weather and grain-future prices. Satellite forecasts for the next 24 hours, revised three times daily, include full-color maps. Quotations from the Winnipeg Commodity Exchange are updated every 15 minutes.

Infomart also supplies information on livestock, seed and feed, herbicides and fertilizers, farm equipment, livestock and poultry diseases, and the government's agricultural services. In a lighter vein, Infomart offers restaurant reviews; season schedules and ticket information for theaters, symphonies, ballet, and hockey teams; and much more.

Another service, teleshopping, allows subscribers to order up to 300 items from the Hudson's Bay Co. Each item appears on the screen with an illustration and descriptive copy; if the viewer wants it he presses the number "1" on his keyboard. The computer asks him to enter the item code, number of items wanted, size and color, his credit card and telephone numbers. Hudson's Bay ships the order.

Another Telidon-linked service offers academic courses. "Computer-aided instruction," Arthur Ballegeer of Cybershare, another videotex supplier, explained, "permits students to learn at their own pace, whenever it's convenient for them. It also maintains a certain standard wherever a course is taken, which may include small communities that don't have teachers qualified in every subject."

Next step: monitoring

So far, the Telidon services—Infomart and Cybershare—are free to these test subscribers. Therefore no identification numbers have been needed. But to find out how much each subscriber is using them, ID's will be assigned to those who agree to be monitored. This should answer an important question: How much are the French-speaking families, which make up about one-third of the group, using the computer data bases, most of which are in English?

No other kind of monitoring will take place, Sigurdson assured me. To do so would intrude on subscriber privacy—and the trial will be precedent-setting. He is optimistic about the outcome.

"The day will come when the sum total of human knowledge is available over a TV monitor. For the select people who live in Elie and St. Eustache, that day has already dawned." PS

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Mini power tools

—not just for hobbies

High-rpm tools—hand-held or mounted—can be invaluable to the DIY'er

By GEORGE R. DRAKE
PHOTOS BY GREG SHARKO

Projects around the house often seem to call for the tools you don't have, or never thought you'd need. There is always some rusted bolt that yields grudgingly at best to the hacksaw, or a small corner or metal railing that you can't sand despite the number of runs you make at it—and despite your bruised knuckles.

Mini power tools could be the answer. Because of their small size, high performance, and versatility, midget power tools are almost indispensable for many do-it-yourself jobs. They use high-speed, low-torque motors. They have a light touch on the work piece and can do the same job a low-speed tool does without requiring the higher torque and greater pressure.

How? Say a bit has 12 cutting edges (flutes) and rotates at 25,000 rpm, a typical top speed. That means that every minute the bit makes 300,000 cuts, enough to whittle most projects down to size.

A high-speed, low-torque motor is easy to make small and lightweight so that it fits into the hand or easily on a bench, hence its use in small tools. In general, two kinds of motors are used in the small tools: universal and permanent-magnet. Universal motors use a wire-wound stator, which is larger than a permanent-magnet stator. So universal motors are generally used with stationary flexible-shaft tools. Universal motors run at slower speeds (to about 20,000 rpm) but have greater torque. The Foredom RM series universal motors have an electronic feedback circuit to provide full torque over the entire speed range. Smaller permanent-magnet motors (used in hand-held mini tools) operate at up to 30,000 rpm, but the higher the speed, the less torque.

What to look for

Ideally, a mini power tool should be light and easy to handle, and have a speed variable to 30,000 or 35,000 rpm. It should not slow down when tool pressure is applied to the work piece (i.e., there should be ample torque at high speed as well as at low speed). The tool should accept various-size accessory shanks easily, not get overheated, should be reliable and long lived—and be low in cost. Unfortunately, you can't get all of these features in one tool, but you can find a reasonable compromise based on your anticipated uses.

A flexible-shaft tool (with hand piece) has the advantages of being smaller, lighter, and cooler in operation than a tool with a built-in motor. The hand piece's smaller size and lighter weight help prevent hand and arm fatigue and let you reach into tight spots. Sometimes the flexible shaft becomes a nuisance, because it can't be bent acutely and tends to pull on the end of the hand piece. Relocation of the motor usually solves this problem, however.

The flexible-shaft tools have a slight advantage at a workbench—the motor can be set to one side or above the work piece, if necessary. For portability, such as when you need the tool for small jobs around the house, the built-in motor tool has an advantage. Most professionals, however, seem to prefer the flexible-shaft designs.

You can, of course, buy just a flexible shaft to be powered by an electric drill or drill press, but in all likelihood you'll be disappointed by the relatively slow speed compared with a mini power tool. Drill motors can never duplicate the high speed and light touch of the mini tools.

Keep in mind, too, that the better the bearing system of a tool, the longer service it will give. Bearings reduce friction and subsequent heat. In mini power tools, either sleeve or ball bearings are used. For general use, motors and hand pieces with sleeve bearings are adequate. But for heavy use, you might want to pay the extra for ball-bearing tools, which are more likely to last longer and be more reliable. Sleeve bearings require periodic lubrication, while ball bearings are generally factory lubricated and sealed.

There are two ways to secure the shaft of an accessory to a mini tool: with a collet or a chuck. For drills and accessories with shafts up to 1/8 inch in diameter, one of several different-size collets is used. You have to change the collet depending on the diameter of the shaft on the accessory. On some flexible-shaft tools, you use a hand piece with a geared chuck, which accepts all shafts up to 5/32 inch diameter.

When the collet is tightened on the hand-helds, you press a spring-loaded locking pin, which holds the shaft as the collet nut is tightened with a wrench. On flexible shafts, a pin passes through the hand piece to hold the shaft immobile.

For all but the most general uses, it's desirable to be able to vary the

Continued

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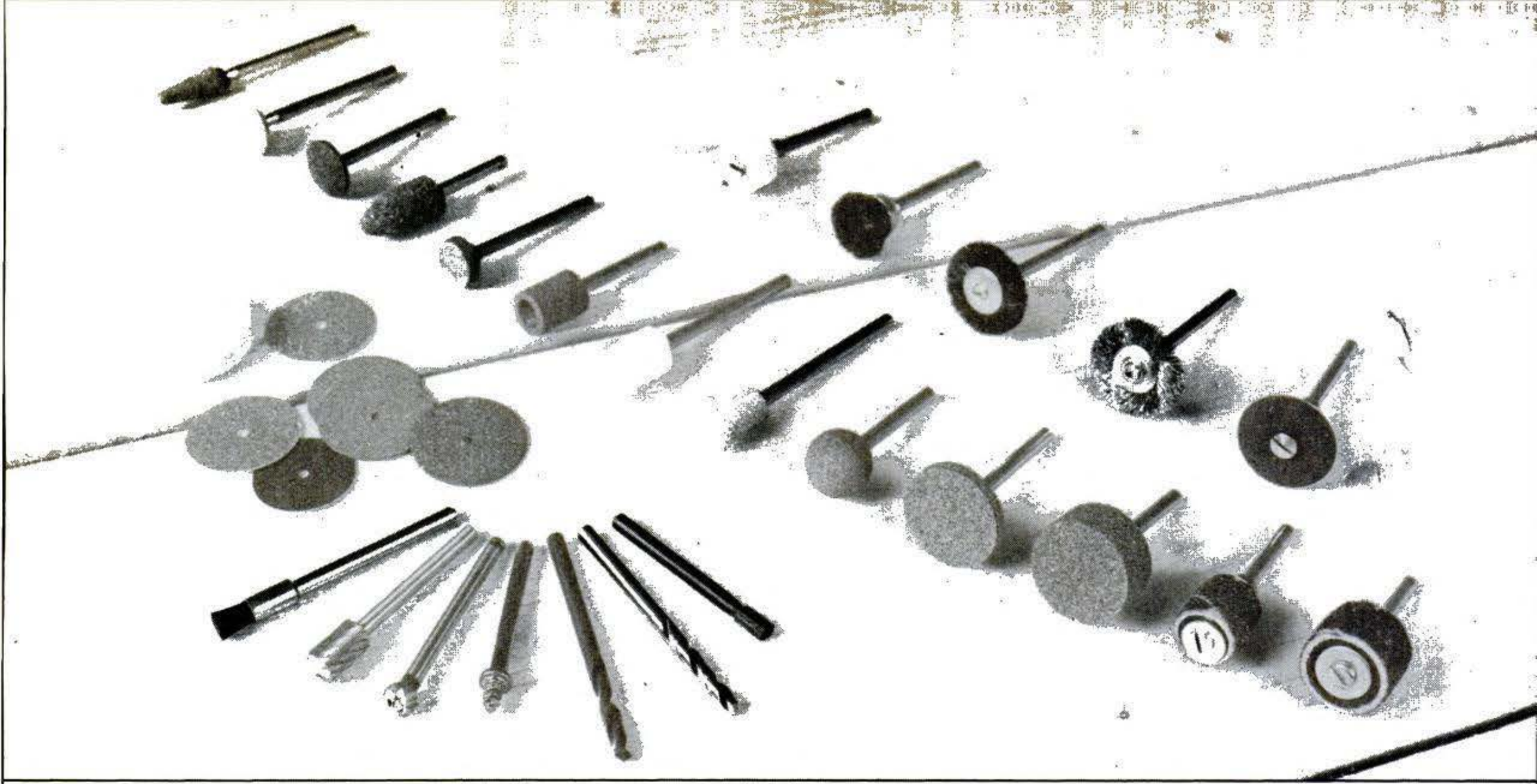
Array of mini power tools for home use includes (clockwise from top left): Foredom CC, Dremel 270, Sears 572.2517111, Dremel 245-5, Weller 651, Dremel 380-5, Sears 572.251581, Black & Decker 9416, Sears 572.251431, Foredom RM. The flexible-shaft machines are generally more powerful, but less portable.



Accessories for mini power tools include a variety of abrasive cones, balls, wheels, and discs. Pictured are (top) buffing and polishing wheels, abrasives (center), and sanding discs, drills, burrs, arbors, and brushes (bottom).

speed of the accessories you'll be using. I like to vary the speed because it sometimes just doesn't feel safe to have the tool going full out. From a practical standpoint, of course, it's essential to adjust the speed to the job. Slower speeds tend to reduce friction (and thus heat) on the work piece. Faster speeds are best for roughing out a work piece. Remember, too, that softer materials are usually cut at different speeds than harder materials. So the variable-speed feature may be worth the higher price if only because it permits precise control of the tool, no matter how fine or delicate the work piece.

Experience in use

I've used three of the tools listed in the accompanying table extensively for home maintenance and do-it-yourself jobs: the Black & Decker 9416, the Dremel 270 (with a bench-mounted speed control), and the Foredom CC series hang-up model (with a foot-activated speed control). In preparing this article, I've also used the other tools, but less extensively.

The Black & Decker 9416 sits next to my bench on a pedestal made of plywood and 2×4's. Since I'm left-handed, I like it at my left, but the tool and mount can be moved to the right for other members of my family. The motor sits in a carrousel that swivels and tilts, allowing me to position the shaft-driven hand piece easily. The carrousel also stores my most frequently used accessories. The speed and on-off control is a sliding switch on the motor. This suits me well since I prefer having the speed control located away from the hand piece.

Freedom of action

I use the Dremel 270 when I need a tool away from the workbench (as in drilling holes in paneling or molding, and for bicycle or automotive work). Because the 270 is single speed, I have to take my Dremel remote-speed control along if I need less than 30,000 rpm, though admittedly I'd be better off with a built-in variable-speed motorized tool such as the Dremel 380-5 or the Sears 572.251581 if I needed to use slower speeds.

One plus for the Dremel hand-helds is that they fit into accessories you might find useful, such as a router attachment, a drill press, and a universal holder. Because Dremel manufactures for Sears, the Sears tools also fit the Dremel accessories.

Versatility

The Foredom tools are made for the serious DIY'er. All of the tools use a flexible shaft and either hang or mount on a pedestal. Speed controls can be purchased as an option, as can a variety of hand pieces.

I have a Foredom CC series hanging on the back of my workbench with its foot-controlled rheostat on the floor and a No. 30 hand piece on the end of its flexible shaft. I use it for general-purpose work: drilling, sharpening, deburring, cleaning, and cutting off metal pieces. The No. 30 hand piece with its geared chuck is easier to use than the tools requiring a change of collets for different-diameter accessory shafts. When I need more than 14,000 rpm, I snap out the No. 30 and install Foredom's No. 35 hand piece, which increases the input speed by 2½ times (thus, the 14,000-rpm input becomes 35,000 rpm at output).

The Sears 572.2517111 is the smallest of the motorized tools listed in the table. It has only a single speed and tends to slow down when even a slight load is put on it, as when carving white pine with a router bit. It also

The many uses for mini power tools

- Cutting off rusted bolts and nuts
- Cutting off excess metal and oversized bolts
- Drilling holes in paneling and walls for picture hangers
- Drilling screw holes for curtain and shade hangers
- Predrilling nail and screw holes in molding, picture frames, and small work pieces
- Cleaning and polishing metal
- Cleaning flatware
- Engraving identification in valuables
- Reslotting stripped screw heads
- Polishing knobs, metal buttons, and jewelry
- Drilling and polishing plastic
- Sanding small wood and plastic work pieces
- Carving decorations in wood
- Reshaping screwdriver tips
- Freehand routing
- Grinding
- Removing rust
- Engraving glass and metal
- Removing excess solder and weld material

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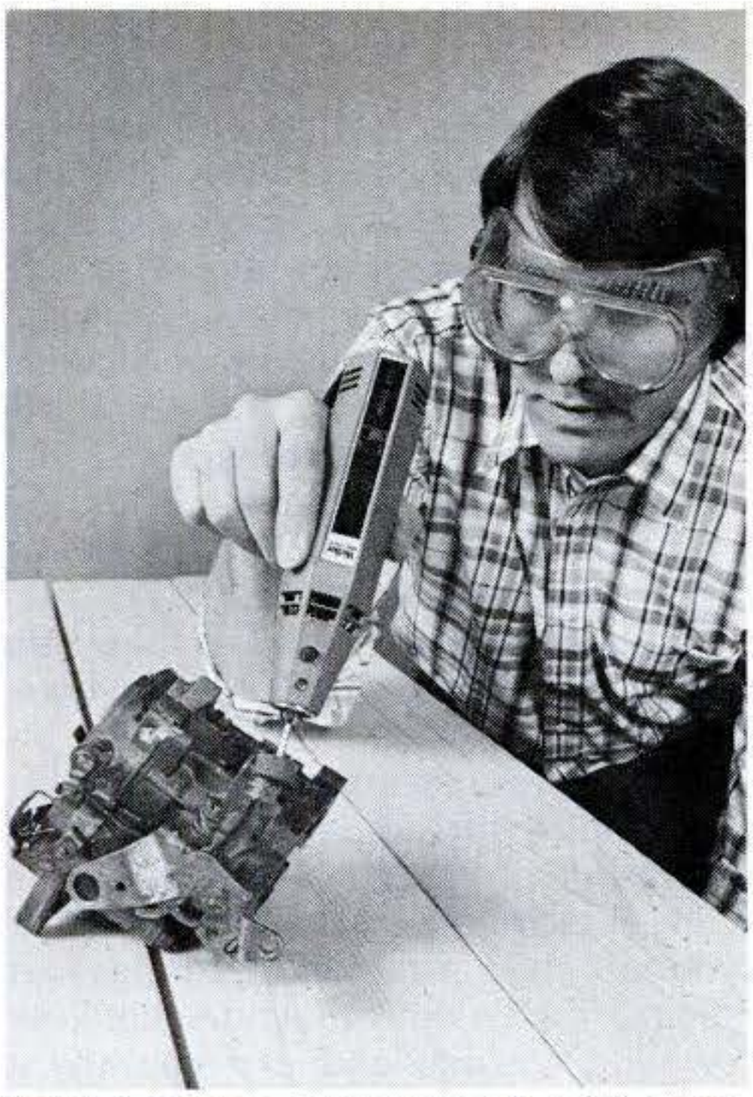

Built-in-motors of hand-held mini tools allow freedom of movement.

Accessories that give versatility to mini power tools

- Cutting wheels—for slicing and cutting off metal
- High-speed steel and tungsten carbide cutters—for shaping and hollowing metals, plastics, and woods
- Small engraving cutters—for engraving, carving, and routing in wood, plastic, and soft metals
- Aluminum oxide wheels and points—for sharpening, deburring, and general-purpose grinding of steel, malleable iron, porcelain, and glass
- Silicon grinding points—for grinding hard steel, glass, gemstones, and such materials as aluminum and brass
- Sanding drums and discs—for shaping and sanding wood and fiberglass, removing rust, and polishing metal
- Wire brushes—for removing rust and corrosion and for polishing metal
- Bristle brushes—for cleaning and polishing jewelry, silverware, and metal surfaces
- Rubber polishing wheels—for polishing metals and stones
- Polishing points, wheels, tips, and compounds—for polishing metals and plastics and for honing tools
- Router bits—for routing, inlaying, and mortising in wood and other soft materials
- Rubber-bonded abrasives—for polishing, removing rust, and smoothing and sharpening metals

gets hot to the touch quite rapidly. The Dremel 245-5 is similar but does not run as hot, though it does get sluggish under a light load.

The Sears 572.251581 motor tool has a variable-speed control built into its on-off switch. Mine has a problem: The control knob vibrates off as I use the tool.

Many times, as when buffing, cleaning, polishing, or sharpening, it would be a good idea to secure the motorized tool or the hand piece. This can be done by carefully placing the tool in a vise; it should be protected with cloth or rubber strips and the vise tightened only enough to hold the unit.

In buying a midget power tool, your main concern should be the motor and hand piece. Forget the "gingerbread": the fancy packaging and the type of accessories supplied with the basic tool. Accessories can be bought at most hardware, department, and hobby stores and can be mail-ordered from many suppliers. PS

MANUFACTURERS' LIST
Black & Decker (U.S.) Inc., Towson MD 21204. **Dremel** Division of Emerson Electric Co., 4915-21st Street, Racine WI 53406. The **Foredom** Electric Co., Bethel CT 06801. **Sears, Roebuck** and Co., Sears Tower, Chicago IL 60684. **Weller,** The Cooper Group, P.O. Box 728, Apex NC 27502.

Buyer's guide to mini power tools

Manufacturer	Name	Model	rpm	Current (amps)	Hand-held?	Flexible-shaft length (in.)	Weight of hand piece (oz.)	Size of hand piece (in.)	Collet or chuck?	Price	Comments
Black & Decker	Rotary Hobby Shop	9416	Variable 0–19,000	1.8	No	33	3.5	4½ L 1 1/16 D	Collet	$ 80	Combined sliding on-off and variable-speed control. Comes mounted on a carrousel that holds accessories. Price includes small accessories kit.
Sears (Craftsman)	Hobby Tool	572. 2517111	30,000	0.5	Yes	n.a.	9.5	6 L 1½ D	Collet	$ 33	The smallest of all motorized tools listed. Single speed. Price includes small accessories kit.
Sears (Craftsman)	Hobby Tool	572. 251581	Variable 5,000–28,000	0.9	Yes	n.a.	13.5	7 L 1⅝ D	Collet	$ 75	Combined on-off and variable-speed control. Price includes small accessories kit.
Sears (Craftsman)	Flexible Shaft Hobby Tool	572. 251431	25,000	0.95	No	30	2.5	4¼ L ¾ D	Collet	$ 80	Protective sheath of flexible shaft is plastic. Motor tilts and rotates in base.
Dremel	Moto-Tool	245-5	25,000	0.6	Yes	n.a.	11	7 L 1 11/16 D	Collet	$ 47	On-off switch on end. Single speed.
Dremel	Moto-Tool	270	30,000	0.8	Yes	n.a.	11	7 L 1 11/16 D	Collet	$ 56	Single speed. On-off switch on side.
Dremel	Moto-Tool	380-5	Variable 5,000–28,000	0.9	Yes	n.a.	13	7 L 1 11/16 D	Collet	$ 78	Combined on-off and variable-speed control.
Foredom	Hang-Up Model	CC Series	14,000	0.8	No	34.5	*	*	*	$119	1/10-hp motor. Bench-type mount available. Can be connected to speed control.
Foredom	Bench Model	RM Series	Variable 0–14,000	1.0	No	34.5	*	*	*	$175	Heavy base. Motor tilts and rotates. Combined on-off switch and speed control.
Weller	Mini-Shop	651	Variable 5,000–28,000	1.1	Yes	n.a.	14	7½ L 1 15/16 D	Collet	$ 62	On-off switch on side. Variable-speed control on end.

*Hand pieces are interchangeable and will accept either collet or chuck.

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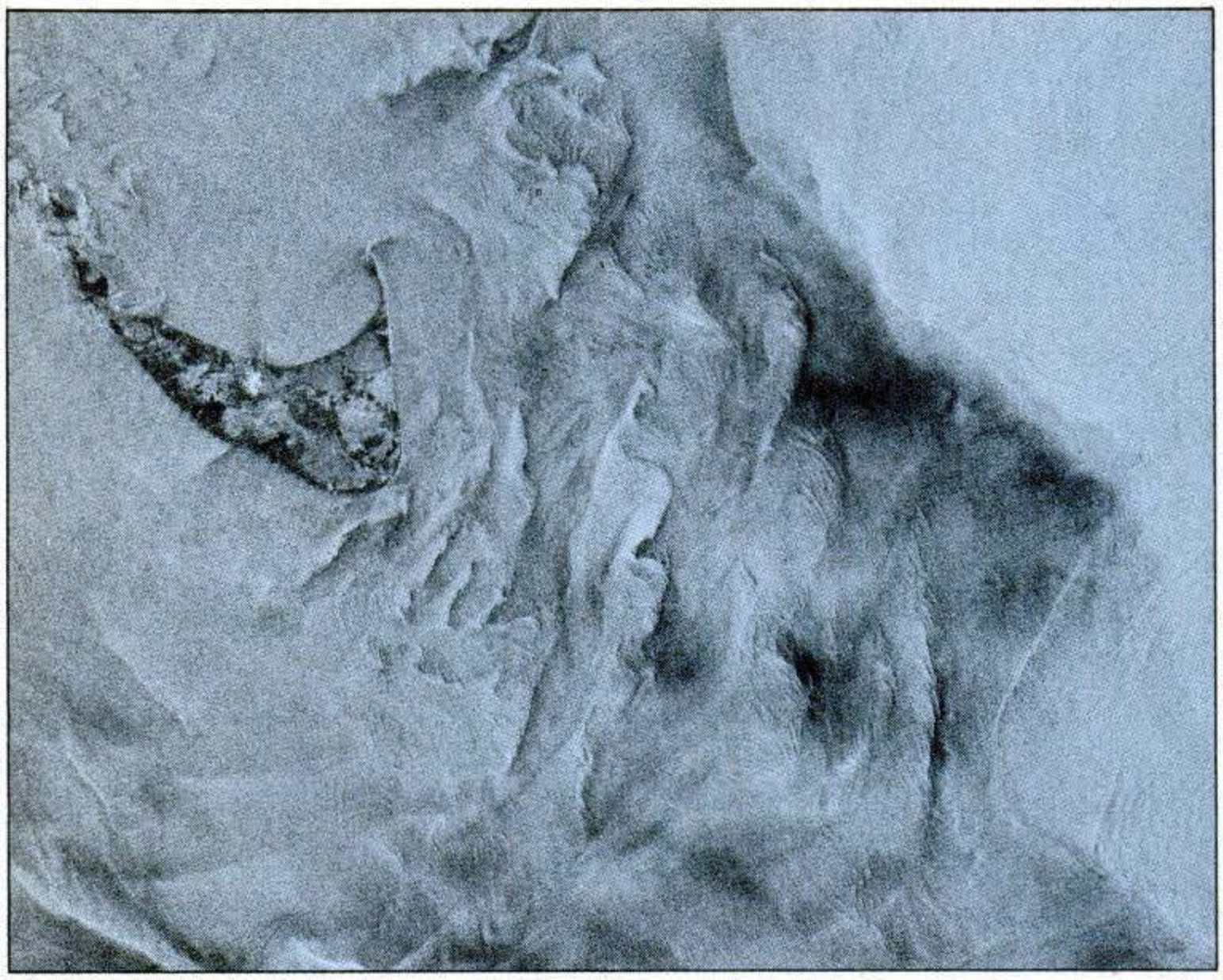
Synthetic-aperture radar

gives unexpected views of the ocean floor



Nantucket Island and details of treacherous shoals show clearly in this radar image.

A dying satellite sent back photos that are still baffling scientists

By LEE GREATHOUSE

When Seasat, the first satellite specifically designed to study the oceans, was launched in 1978, researchers thought they were going to learn much about ocean winds, waves, and currents. The satellite failed only 100 days after launch—but not before sending some startling pictures.

At several sites, including the English Channel and Nantucket shoals, one of the instruments aboard—synthetic-aperture radar (SAR)—produced pictures that clearly showed the ridges and valleys of the ocean floor. "It looks like a map" of the bottom, Larry McGoldrick, of NASA's Oceanic Processes Program, said of a picture of the shoals.

Researchers are still puzzling over the results. The short electromagnetic waves of SAR do not penetrate the water's surface beyond a few centimeters. Yet, for the first time, it appears possible to get a look at the ocean bottom at considerable depths from the air and from space without having to undertake a time-consuming depth survey from a ship.

SAR gets its name because it uses the satellite's motion to create, in effect, a very long antenna, yielding a larger "synthetic aperture" of view. How could it see the bottom?

In his office at NASA headquarters in Washington, D.C., McGoldrick walked to a blackboard and drew two horizontal lines, pinched in the middle, hourglass fashion. The bump in the lower line represented a protuberance on the ocean floor. "According to one theory, as water flows over the bump, it must flow faster, because of the Bernoulli effect," McGoldrick said. The ocean surface is drawn down slightly, altering its slope.

Robert Beal of The Johns Hopkins University Applied Physics Laboratory space department supplied what he thinks is a more important effect. "As currents flow over uneven topography, the motion of the water 'stresses' the surface, altering the amplitude and length of the 30-centimeter-long waves that the L-band [23.5-centimeter wavelength] radar of the Seasat SAR was designed to see."

A good deal of research has been done on methods of remotely sensing ocean depth in shallow regions, but most of these attempts have used visible light, including lasers, to measure light reflected from the bottom. These techniques are limited to clear water, clear weather, and daylight hours. SAR's can penetrate cloud cover and storms, and can operate at night.

"To get images like a contour map, water depths must be about 50 meters or less," says radar scientist Robert Shuchman of the Environmental Research Institute of Michigan, "although," he adds, "evidence of deeper features such as seamounts and ocean ridges has shown up."

SAR probably never will be useful as a precise depth finder, according to Shuchman. For bottom topography to show up requires a favorable combination of currents, winds, orientation of the bottom contours, and other variables. But "detecting hazards," not conducting depth surveys, is SAR's prime potential value, according to James Hammack of the Defense Mapping Agency Hydrographic/Topographic Center. "You survey Cape Hatteras with conventional methods, and two weeks later a storm comes through and your survey is out of date." Hammack pointed out a sizable advantage of a satellite-borne SAR: "It covers in a few seconds what a ship would take years to do."

Shoals aren't the only hazard that might be detected. In a study in which airborne radar was used to examine the North Sea, researchers reported detecting the location of a submerged shipwreck off the coast of the Netherlands.

As satellite instruments go, SAR's are expensive. An experiment to examine in detail how the startling SAR images are produced, originally scheduled to take place in Nantucket shoals in the fall of 1982, has been canceled because of budget cuts, according to Gaspar Valenzuela of the Naval Research Laboratory. But an oceanography satellite, planned for launch in 1987 by the European Space Agency, will carry an SAR. ■

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Now: 96% efficient pulse-combustion furnace

With 70 tiny explosions per second, this new gas furnace captures nearly all the fuel's heat. A bonus: It needs no chimney

By EVAN POWELL

Even though the countdown was going smoothly, the drama was intense. As the count reached T minus 30 seconds there was a slight whirring noise. Then, right on schedule, we had ignition.

This blastoff didn't occur at Cape Canaveral but in the basement of a house in Greenville, S.C. I wasn't in the company of aerospace engineers, but with the city heating inspector and officials of the Piedmont Natural Gas Co. The machine was not the space shuttle, but one that may prove to be of more immediate significance to homeowners—a new type of heating system, the Lennox pulse-combustion furnace.

Inside the modest beige cabinet before us was a burner that works more like your car's engine than like a conventional furnace burner. Very small charges of gas and air are admitted to the combustion chamber where they ignite and burn, producing 60 to 70 mini-explosions every second (see box, next page). Result: Combustion is so complete that nearly all the fuel's heat energy is released.

Furthermore, the furnace's heat-exchanger network extracts most of the heat from the exhaust gases. In a conventional furnace, these gases must remain above 300 degrees F (they're usually much hotter) so that the chimney will draw properly and water vapor in the gases won't condense. That can represent a great deal of lost heat. But the Lennox Pulse furnace has no chimney—flue gases are vented through a small plastic pipe. The force generated by the combustion process pushes them out. The flue gases are cooled to less than 100 degrees, the water vapor condenses, and its latent heat (released when a gas changes to a liquid) is captured. The heat exchanger is specially designed to handle the condensate, which then flows away through a drain line.

The pulse-combustion concept is not new. In fact, a boiler, the Hydropulse, made by Hydrotherm, Inc., in Northvale, N.J., has been on the U.S. market for about three years ["High-Efficiency Home Heating," PS, Nov. '79]. But a pulse-combustion furnace is news. (A furnace heats by circulating warm air, a boiler by circulating hot water or steam.) The Pulse furnace I was installing was the first one Lennox had released for home testing without company supervision.

Infamous ancestor

Making a practical pulse-combustion furnace is trickier than making a boiler. The reason: The combustion process is noisy—it's derived from the technology that gave us the German V-1 buzz bombs of World War II. Without the damping effect of the boiler's surrounding water jacket, that sound is difficult to soften.

In the early '60's, the American Gas Assn. Laboratories in Cleveland, under a Gas Research Institute contract, began development work on a pulse-combustion furnace. Eventually, AGA Labs sought a furnace manufacturer to assume the project. Lennox was the only taker. In 1976, AGA gave Lennox two crude working models of the Pulse furnace. "There were two good things about them," says Tom Morton, one of the chief project engineers. "They worked, and they were efficient. But the people in the lab had to wear earmuffs to tolerate the noise."

To bring the noise to an acceptable level, the engineers experimented with different materials and different weights of materials for the critical components. Each time one was changed, they had to back up and see how that affected all the others. Slowly they arrived at a satisfactory combination. They also tinkered with the placement of a baffle in the tailpipe and a resonator to reduce sound levels at certain frequencies. Finally, they mounted the combustion-chamber and heat-exchanger assemblies on damping pads and insulated the cabinet with fiberglass.

In 1980, some prototypes were installed in homes for field tests—with very good results. In fact, at a house in Cleveland where one was installed that fall, the gas-meter reader knocked on the door in January and asked if the family had been away for the winter. Seems their gas bill was less than half what it normally should have been. When he learned the reason, the meter man called Lennox to see if he could get a pulse-combustion furnace for his own house.

Tests bear out such anecdotal evidence of the furnace's efficiency. Fossil-fuel heating systems are rated by Btu-per-hour input (the heat available in the quantity of fuel burned in an hour) and output (the heat actually extracted to heat your house). Typically, a gas furnace of 100,000-Btu/h-input rating will have an output of about 70,000 Btu/h. The difference be-

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tween input and output goes up the chimney in the form of heat, unburned fuel, and water vapor.

Furnace technicians accept such inefficiency and size heating systems accordingly. But the pulse-combustion furnace changes the rules, as I realized when conferring with David Chase, Lennox's director for government and public relations, about the size of my test furnace. He suggested an 80,000-Btu/h-input model. I immediately calculated about a 56,000-Btu/h output. "Sounds too small," I replied. "What's the output?" "Just about 80,000 Btu," Chase replied with a grin.

The Pulse furnace's annual fuel-utilization efficiency (AFUE), determined according to Department of Energy standards, is 91 to 96 percent, depending on the model. As the name implies, this rating is designed to measure efficiency on an annual (or seasonal) basis. It takes into account not only the percentage of the heat energy captured in the combustion process, but also off-cycle heat loss: the heat that wafts up the chimney while the burner is off. That can be a good bit, since most furnaces draw combustion air from the house and continue to vent heated air up the chimney when the burner is off. The Pulse furnace has a closed combustion system: Combustion air is piped in directly from outside, and, of course, there is no chimney. Thus its off-cycle losses are minimal.

If gas furnaces now in American homes were rated according to the AFUE tests, says Lennox, 30 million would be shown to operate at only 50 to 60 percent efficiency. The Pulse furnace is also notably more efficient than new conventional furnaces: Lennox's own most efficient model (with vent damper and direct-spark ignition) has an AFUE of 78.6 percent—and it's one of the most efficient available. New furnaces at the bottom of the list on a DOE fact sheet rate a measly 55 percent AFUE.

Put in terms of dollars, if your annual fuel bill is $1,000 and your furnace operates at about 66 percent efficiency, the Pulse furnace would reduce your bill by more than $300. If your furnace is only 55 percent efficient, you'd save around $425. Even if you have one of the most efficient conventional furnaces, you could save about $180 per season.

Lennox expects the Pulse furnaces to sell for around $1,800 installed (though that depends on the ductwork required). A conventional high-efficiency furnace might have an installed cost of $1,200 to $1,600. With the energy savings, however, the Pulse furnace would repay its extra cost within two years, says Lennox.

And since it needs no chimney, the Pulse could actually be less expensive to install in a new house than a conventional fossil-fuel furnace—the chimney can be one of the major costs of a heating system. If your chimney needs repair, the Pulse furnace could also prove a less-expensive alternative. And it allows you to locate the furnace to minimize duct runs or to put it in an out-of-the-way place.

Easy to live with

The Lennox Pulse can replace many newer furnaces—without modification to plenum or duct systems—and almost all warm-air systems with a little modification.

Such accessories as humidifiers and air cleaners work with the Pulse furnace, and its direct-drive blower will handle air-conditioning coils in nominal ratings of up to five tons.

The thermostat is conventional, and you can use a setback thermostat to reduce your heating costs even more. Internal controls are much the same as for ordinary furnaces, too, so service problems should be minimal.

Installing the Pulse furnace is similar to putting in a conventional furnace except for the venting and condensate drain. A 1½-inch PVC pipe connects to a drain-leg fitting. From the top of this fitting a two-inch PVC pipe takes the flue products vertically or through a wall to the outdoors, while from the bottom a trickle of condensate flows through a small PVC tube to a floor drain. The condensate is slightly acidic but noncorrosive to plastic, tile, cast sewer pipes, and septic tanks. Outdoor air for combustion is piped through another PVC pipe.

Knowing its buzz-bomb ancestry, I was especially curious about how much noise the furnace made. It turned out to be far quieter than I expected, though louder than a simple atmospheric gas burner. The sound is a sort of hum, similar to that of a powered gas burner or an oil burner but without the rumbling.

The sound frequency of the Pulse furnace is such that certain duct systems could pick up harmonics and amplify them. For that reason Lennox insists on sound-isolation techniques that include using pads (furnished) under the cabinet, flexible canvas boots on the plenums, a flexible gas-line connector (furnished), and foam insulation on the supports for the plastic vent and intake tubing. Thus installed, the Pulse furnace could be quieter than the one it replaces.

Lennox claims that the Pulse is also the safest furnace ever produced. Safety controls shut it down long before combustion products could escape. A flame-rectification sensor verifies ignition and locks the gas valve in case of failure. The burner will also shut down immediately if the air intake or exhaust outlet is obstructed.

The Pulse furnace is AGA- and UL-approved, but if you're the first in your locality to install one, you may have to get a zoning variance to vent it through a PVC pipe.

Lennox Industries Inc. (Dept. PC, Box 400450, Dallas, Tex. 75240) will begin distributing the Pulse furnace this fall through Lennox dealers. Upright, upflow models of 40,000-, 60,000-, and 80,000-Btu/h input will be introduced first. Next will come 100,000- and 130,000-Btu/h sizes. Horizontal and downflow models will follow. PS

Operation of the pulse-combustion burner: When the burner is energized, gas and air in precisely metered amounts enter the sealed combustion chamber (1) through separate ports (2) and (3), each backed by a flapper valve. A spark-ignition device (4), much like the spark plug in your car, fires the initial charge, creating the first pulse (5). Each pulse burns only about 0.003 cu. ft. of gas, equivalent to ¼ to ½ Btu. The pressure from the pulse closes the flapper valves, forcing combustion products to travel through the tailpipe (6), the only remaining exit from the chamber. The pulse travels on past the resonator (7), a noise-control device, and into the exhaust decoupler (8), which contains a stagnant air mass that acts as a baffle or cushion and reflects part of the pulse back through the tailpipe into the combustion chamber. In the meantime, a partial vacuum in the chamber, left by the displaced gases, has allowed the flapper valves to open again and fill the chamber with a second charge of fuel and air. The returning pulse ignites the mixture and the cycle repeats. (The igniter plug is used only for the first pulse.)

The force of each pulse creates great turbulence, causing maximum heat transfer and pushing the combustion products through the entire heat-exchanger network. Within the exhaust decoupler, the gases are cooled from 1,200 deg. F to about 350. They are then forced through a fin-and-tube coil (9), where they are cooled to less than 100 deg. As the temperature reaches the dew point (around 130 deg.) inside the coil, water vapor condenses and the furnace captures the latent heat of the phase change. The remaining flue gases exit through a PVC tube, and the condensate drains away (10). Throughout this time, supply air from the house passes across all these components (11), designed for maximum heat transfer, absorbing most of the heat.

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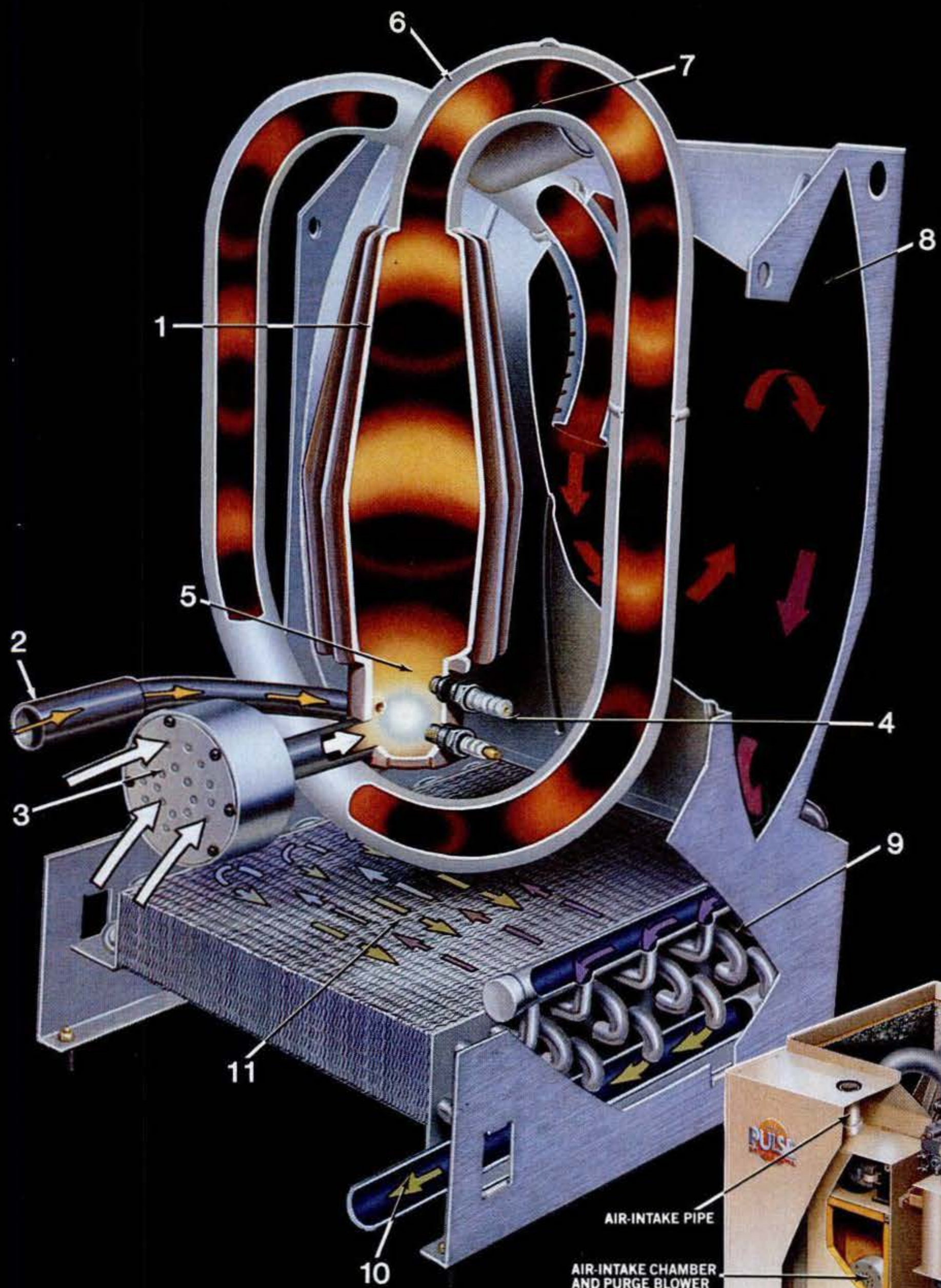

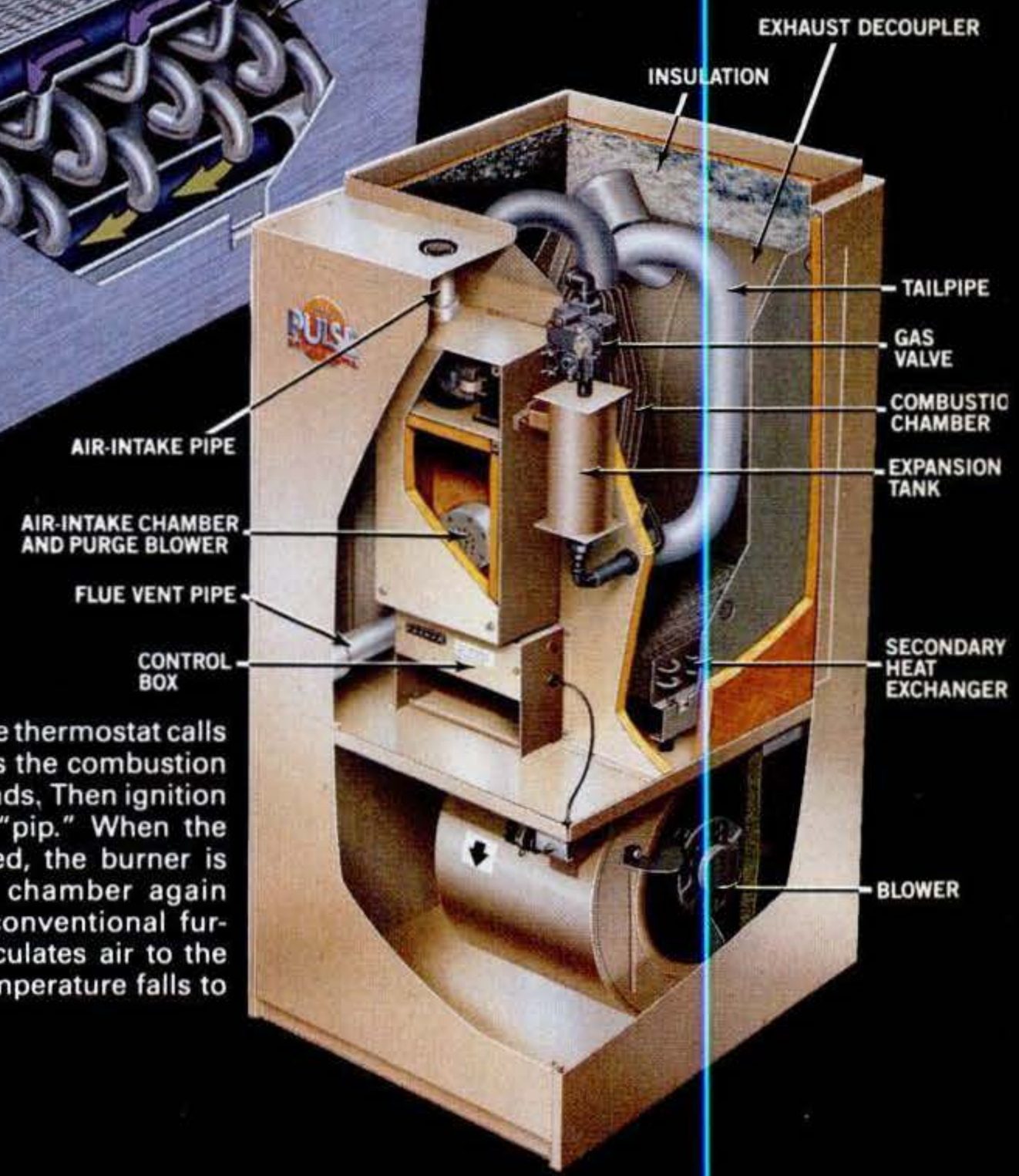

Pulse-combustion furnace looks conventional outside, but not inside. Combustion chamber, tailpipe, and exhaust decoupler make up the primary heat exchanger. Secondary heat exchanger condenses flue gases and captures latent heat. Expansion tank absorbs shock waves created by action of flapper valves (see top diagram) so that they won't affect gas-valve diaphragm.

In operation, when the thermostat calls for heat, a fan purges the combustion chamber for 30 seconds. Then ignition begins with a faint "pip." When the thermostat is satisfied, the burner is turned off and the chamber again purged. As with a conventional furnace, the blower circulates air to the house until outlet temperature falls to about 85 degrees F.

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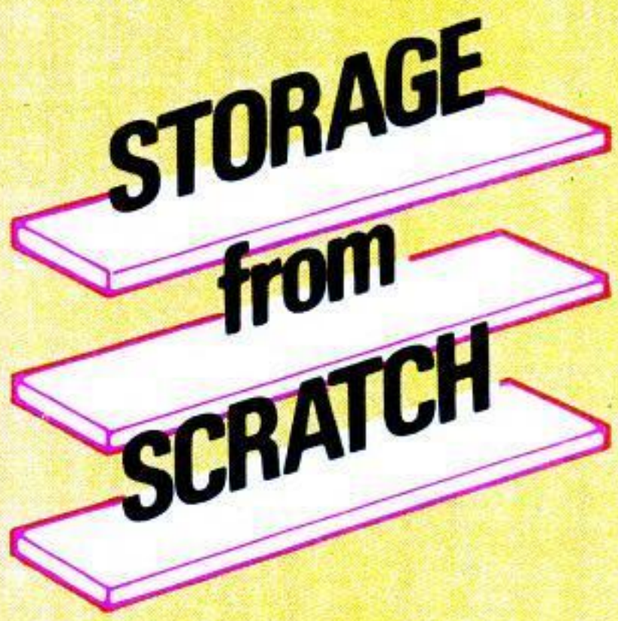
HOME-IMPROVEMENT SECTION



The September issue of PS has traditionally featured a special section on interior home improvements. As summer's easy livin' winds down and outdoor activities shorten with the days, a homeowner's thoughts turn back inside—usually with an impulse to make the old place fresher and more functional for those long indoor months ahead.

Never has that impulse been stronger than this year, with the national economy still in the doldrums and high interest rates still preventing most of us from moving onward and upward toward that home of our dreams. For the foreseeable future, our motto must remain: "Make the best of what you've already got."

One of the greatest needs we face in "staying put" is increased storage space. The longer we occupy a home, the more we accumulate and the less space we have to store it in a practical, organized way. So we're devoting most of this special section to the creation of storage where none existed, as part of our continuing Storage from Scratch series. In addition to the storage counter by a PS editor, shown on this and the next page, we offer plans for three other "created storage" ideas and round out this 15-page section with several features that aren't storage-related.

- "I wanted bookshelves, my wife wanted an étagère," writes Ronald Sieber, "and we were both put off by the high cost of commercial wall systems." Turn to page 104 to see how Sieber built a wall-to-wall display shelf across one end of a room, with enclosed storage below.

- A basement remodeling with a special purpose and flair solves one of the happier accumulation problems: storage of a growing wine collection. And it results in a private tasting room where you can treat guests to a bit of wine and cheese while selecting the vintage for dinner.

- Lally columns, supporting the beam above your garage or basement space, offer ideal anchorage for a storage partition—and, if you equip it with shelved swing-out doors, you double its capacity for storing bulky home-improvement or auto-maintenance supplies and tools.

- For the third consecutive September, we offer a new-house plan by the young "underground" architect, Charles Woods. The first earth-sheltered, sod-roofed home PS commissioned from Woods (for our Sept. '80 issue) brought him over $20,000 in plans sales, so he's submitted a new below-ground design each year since.

- There's still time to re-side your house before winter weather, but first read about the bonus advantages you can get with some advance planning—improving both the architectural lines and the thermal efficiency of your home. Here are three case histories plus tips on sheathing the walls with rigid foam boards beforehand.

- This month's "Shop Talk," further along in the issue, is also devoted to this theme, with reviews of recent home-improvement books we recommend.

Living/dining storage divider

A butcher-block-topped peninsula holds a home bar and record collection

By RICHARD STEPLER
PHOTOS BY JOHN KEATING

I wanted a visual separation between my open-plan living room and dining room. Since the dining area is an interior space with no windows of its own, however, the divider could not obstruct light and ventilation from the

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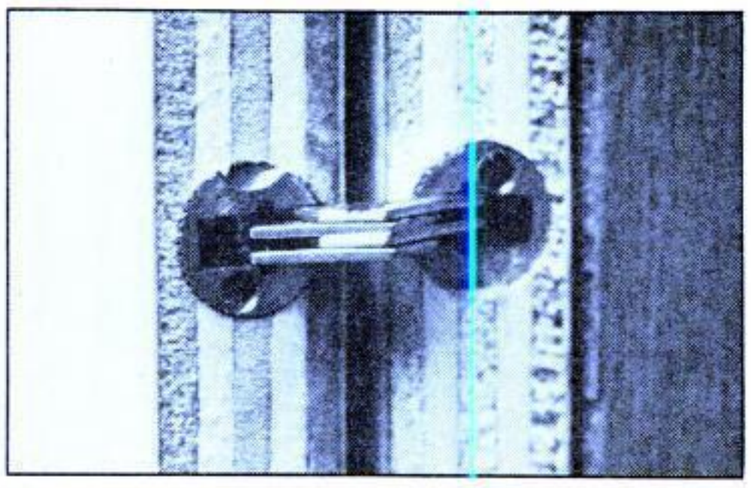
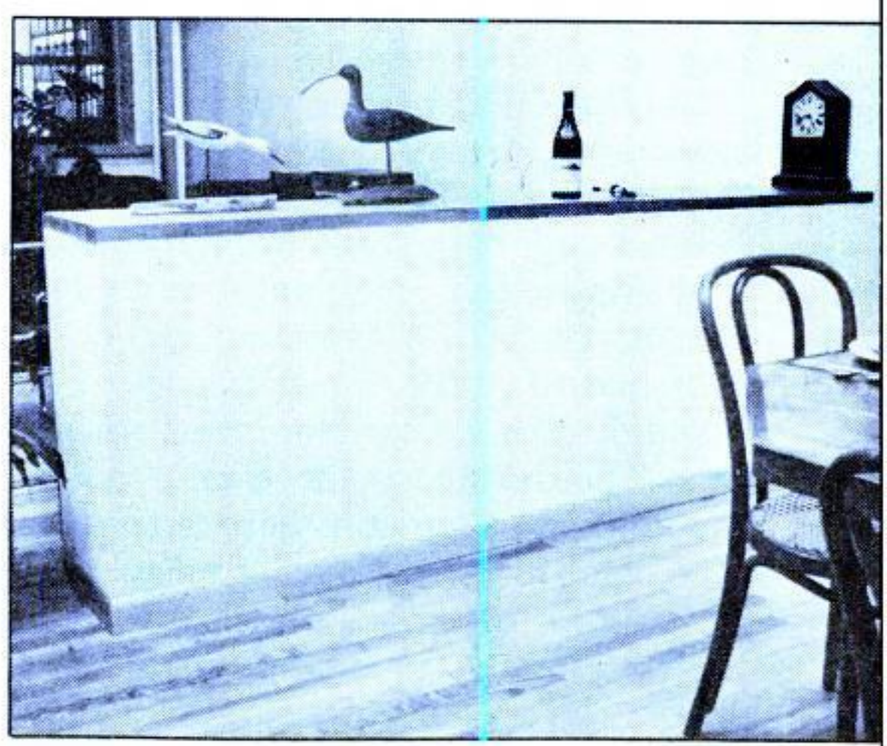


European no-mortise concealed hinges are circular, need only two 14-mm holes for installation (see text for source).



Dining face (above) is flat-white painted gypsum board; living-room side (next page) has three pairs of doors.

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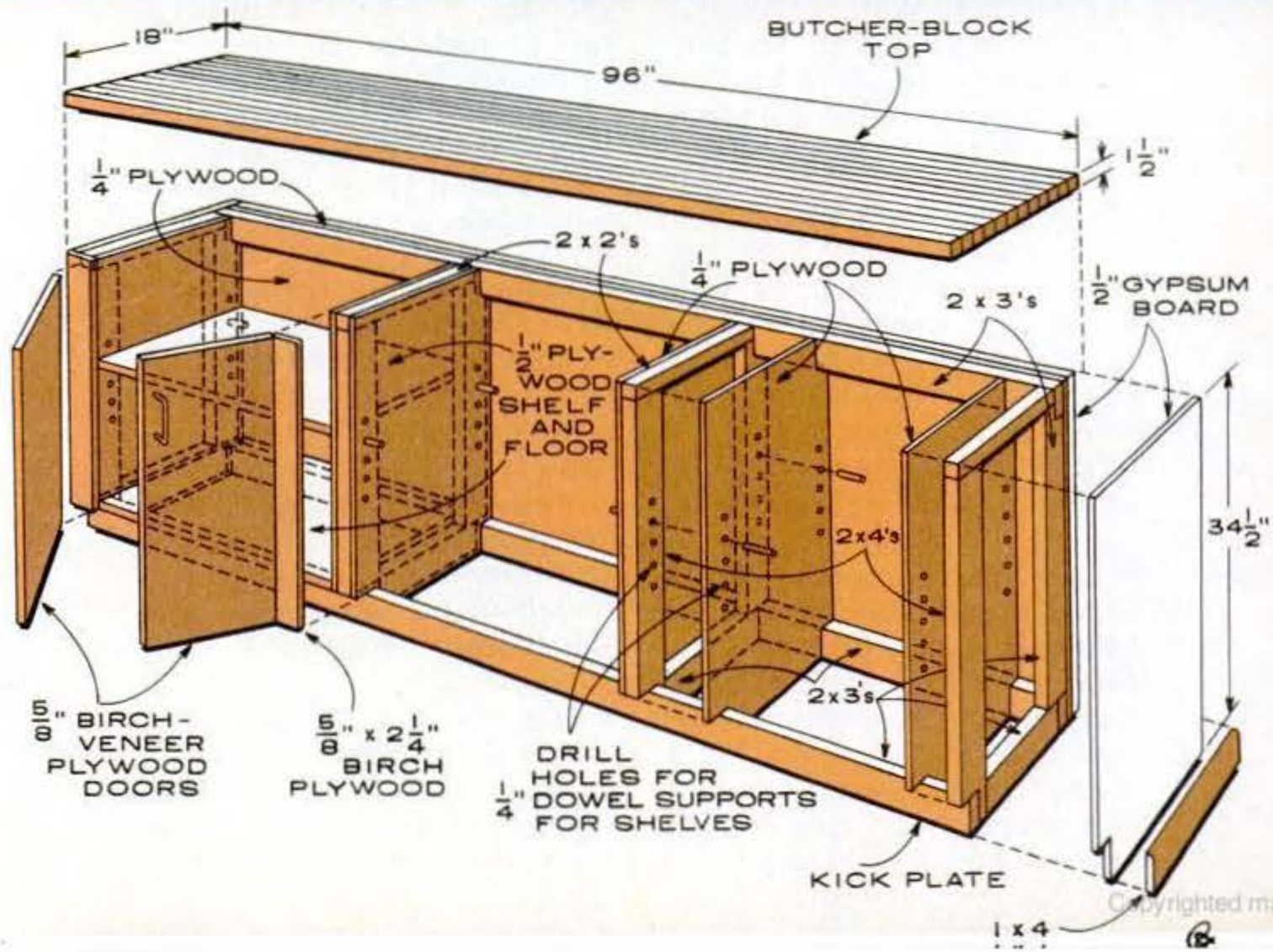
living room. Storage was needed, too.

The eight-foot-long, 1½-foot-wide cabinet above and on the preceding page answers these needs neatly.

Construction begins with the interior frame (drawing); I used construction-grade lumber since it's all hidden behind the ¼-in. and ½-in. plywood that lines the compartments. The butcher-block top came cut to size; I attached it with screws, *predrilled* through the 2×2's from the underside. The divider is faced on the dining side with gypsum board; the living-room face is ¾-in. birch-veneer plywood for a warm, low-maintenance surface. Magnetic catches secure the doors. The clever hinges (above, left) came from The Woodworkers' Store (21801 Industrial Blvd., Rogers, Minn. 55374). Price: $4.50 a pair. PS



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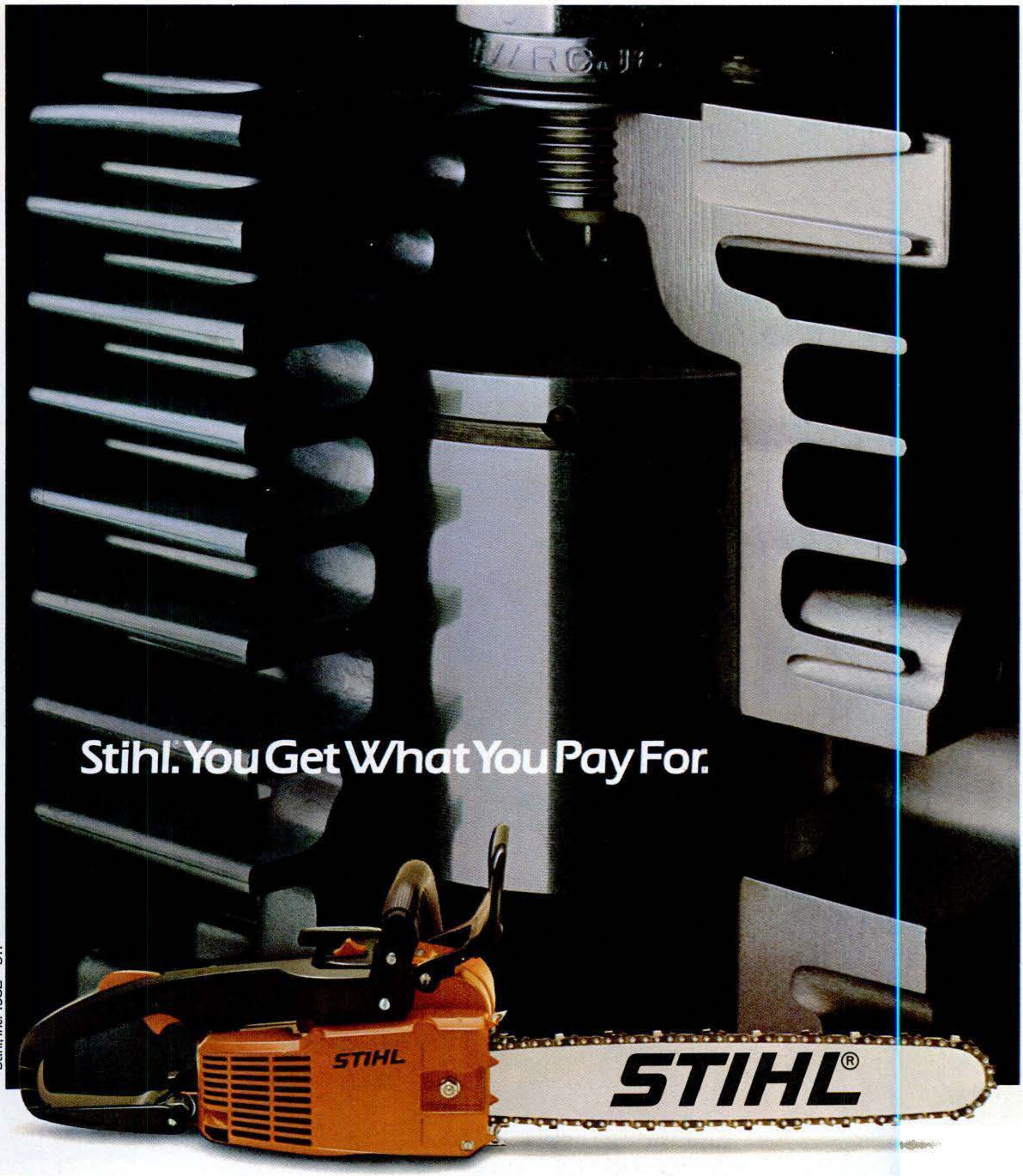

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STORAGE from SCRATCH

Built-in storage wall

(but the wall's built *out*)

This handsome display-storage area was created with simple tools and skills —and only $250 worth of materials

By RONALD D. SIEBER

Our small condominium lacked shelf space, and the more we traveled (collecting treasures along the way) and added to our book collection, the more acute the need became. Considering how much space we wanted, store-bought shelf units were beyond our budget. Furthermore, we also needed cabinet space to store bulky items and paper work.

Our solution: We created a wall of arched open shelves with enclosed storage below by building out from an existing wall. By using low-cost materials and shopping for bargains, we built this 11½-ft.-wide by nearly nine-ft.-tall unit for only $250.

We designed it to be 12 in. deep, and happened to have wall studs and ceiling joists at just that distance from the existing wall. So we nailed the outer frame for the new wall to them. Otherwise, we'd have attached these frame members with toggle bolts. To support the new counter top we nailed a horizontal 2×4 to the new studs and a 2×2 across the existing wall at the same height.

For the back wall of the display arches, we chose Luan, a close-grained plywood. Stained and varnished, this inexpensive ¼-in. sheathing would resemble mahogany paneling. Framing for the arches is 12 2×2 studs. (The materials list calls for 14 six-footers; the remaining two serve as nailers for joints in the Masonite facing panels.)

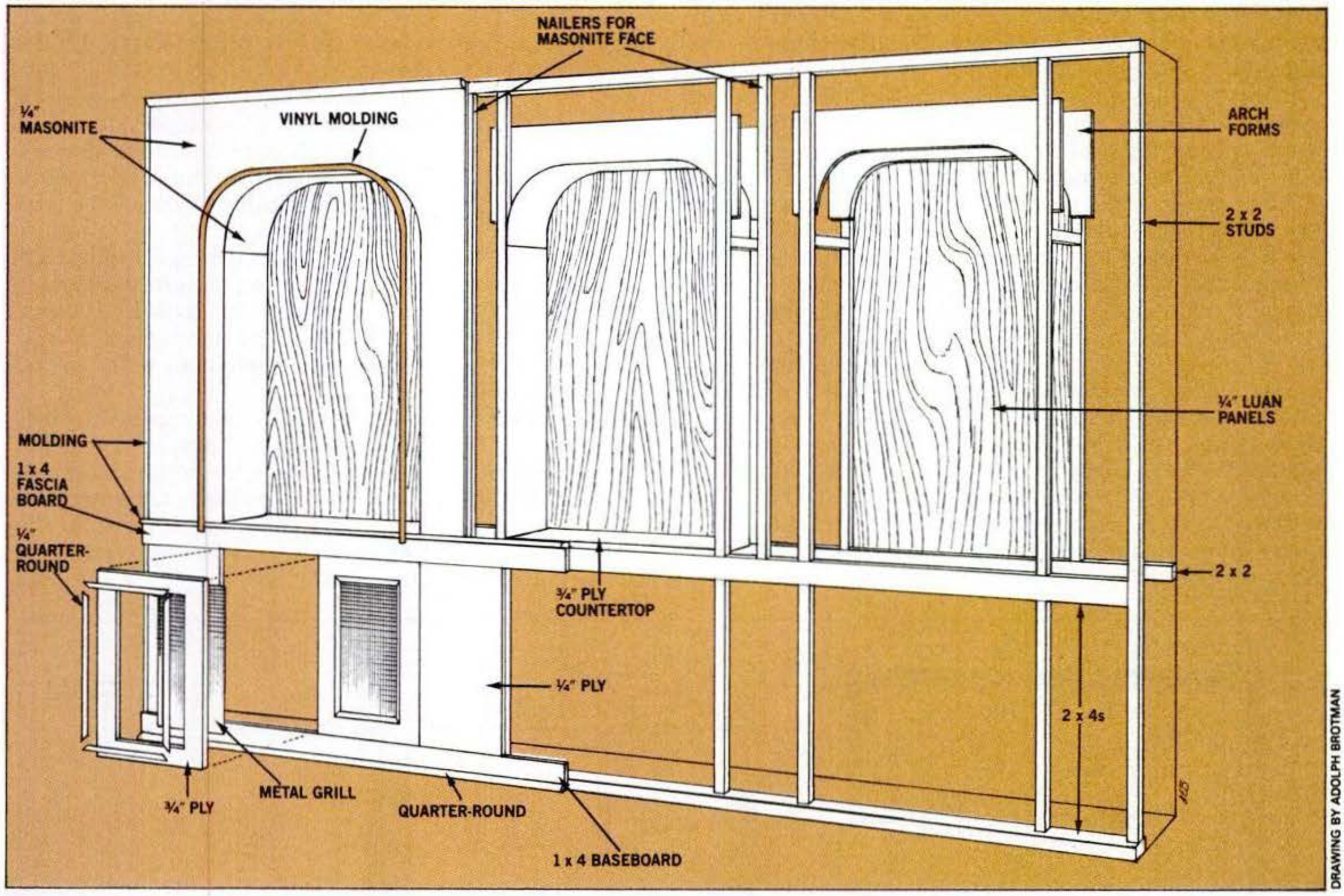
Studs to frame the cabinets are also 2×2's. To form the arches, we cut eight-in.-radius arcs from ¾-in. plywood panels sized to fit the openings. The arches are sheathed in ¼-in. Masonite. We used three pieces for each arcade, predrilled the nail holes in the pieces to be bent, and attached them with wallboard adhesive as well as nails. At the joints between the pieces we used 2×2 nailers.

We used ¼-in. Masonite for the face of the new wall, cutting out the arched openings. Our wall required three 48-in. panels—the center one trimmed to 42 in. to fit between full-width side panels. Since the new wall was to be papered, we primed the Masonite to prevent buckling.

We boxed in the cabinets with ¼-in. ply and attached a 1×4 fascia board along the top and bottom. Counter tops (three panels, each 12 by 30 in. in our design) are of ¾-in. cabinet-grade ply. We trimmed the edge with molding and trimmed the perimeter after wallpapering.

Instead of steam-bending wooden trim to finish the arches, we used inexpensive, flexible plastic trim, predrilling the nail holes. Another cost-cutter was the cabinet doors. We cut them from ¾-in. plywood and cut out the centers, leaving two-in. frames. We then tacked ¼-in. quarter-round molding around the cut flush with the door faces, and inserted metal grillwork from behind.

The ⅜-in. glass used for the display shelves was purchased from a defunct store and cut to size. Cabinet hardware was bought on sale. Even the track lights we added were bought at a bargain. The cost was thus kept low. The time invested: about 45 hours. PS



DRAWING BY ADOLPH BROTMAN

MATERIALS LIST

Nailers: 1 11½-ft. 2×2 (across ceiling)
1 11½-ft. 2×4 (across floor)
2 8-ft.-10½-in. 2×2's (wall studs)
1 11½-ft. 2×4 (counter-top support, front)
1 11½-ft. 2×2 (counter-top support, back)
Studs: 14 6-ft. 2×2's (see text)
6 30-in. 2×2's (framing for cabinets)
Arch forms: 6 pcs. ¾-in. ply 32×20-in. (cut with 8-in. radii)
Back-wall panels: 3 pcs. ¼-in. Luan 3×6 ft. (mounted with wallboard adhesive)
Facing panels: 3 pcs. ¼-in. Masonite 4×6 ft. (further cut to fit)
4 pcs. ¼-in. ply 12½×30 in. (for cabinets)
Arch panels: 6 pcs. ¼-in. Masonite 11½×50 in. (vertical panels)
3 pcs. ¼-in. Masonite 11½×40 in. (curved top panels)
Counter top: 3 pcs. ¾-in. ply 11½×30 in.
Cabinet doors: 6 pcs. ¾-in. ply 14¾×29¾ in.
Metal grillwork cut to fit
Molding: 6 8-ft. lengths vinyl molding (for arches)
30 ft. ¼-in. quarter-round (for doors)
30 ft. ¾-in. quarter-round (for walls, floor)
1 11½-ft. 1×4 fascia board
1 11½-ft. 1×4 baseboard
1 11½-ft. length (for counter-top edge)
Miscellaneous: glass for shelves, shelf brackets, adhesive, nails, paint, varnish, wallpaper, etc.

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STORAGE from SCRATCH

Turn your basement into a host's wine cellar

A small, cluttered basement can become an entertainment room

By CHARLES A. MILLER

What was once a catchall for little-used items can become a place to get away to—a tasting room for sharing your prize wines with friends or for hosting intimate wine-and-cheese parties. Line the walls with bottle bins and you've got storage that lets you buy economically now, taking advantage of case discounts. At last you'll have space for "laying down" young wines to let them mature into the fine vintages you'd otherwise have to pay a fortune for in two to ten years.

This is what Syd Dunton, in cooperation with the California Redwood Assn. (One Lombard St., San Francisco, Calif. 94111), created from a small basement that was previously the location of a gas furnace, water heater, water softener, and a jumble of household paraphernalia.

The basement was a designer's nightmare. It had exposed floor joists overhead, two ugly columns supporting a structural beam, a concrete floor, and a two-ft.-high concrete abutment running around the perimeter, with open stud walls above it.

The job started with insulation: R-11 fiberglass in the stud cavities and a three-mil polyvinyl moisture barrier stapled to the existing studs. That is covered with 1×12 redwood boards, applied at a 45-degree angle.

The abutment was turned into a bench in some areas, covered by 1×12 redwood planks. In the remaining area it's faced with redwood, to produce a wainscoting effect for the wine bins (72 in all) built above it.

The furnace, along with the water heater and softener, is enclosed behind a partition wall insulated with fiberglass batts. Access to the utilities is through a hinged panel.

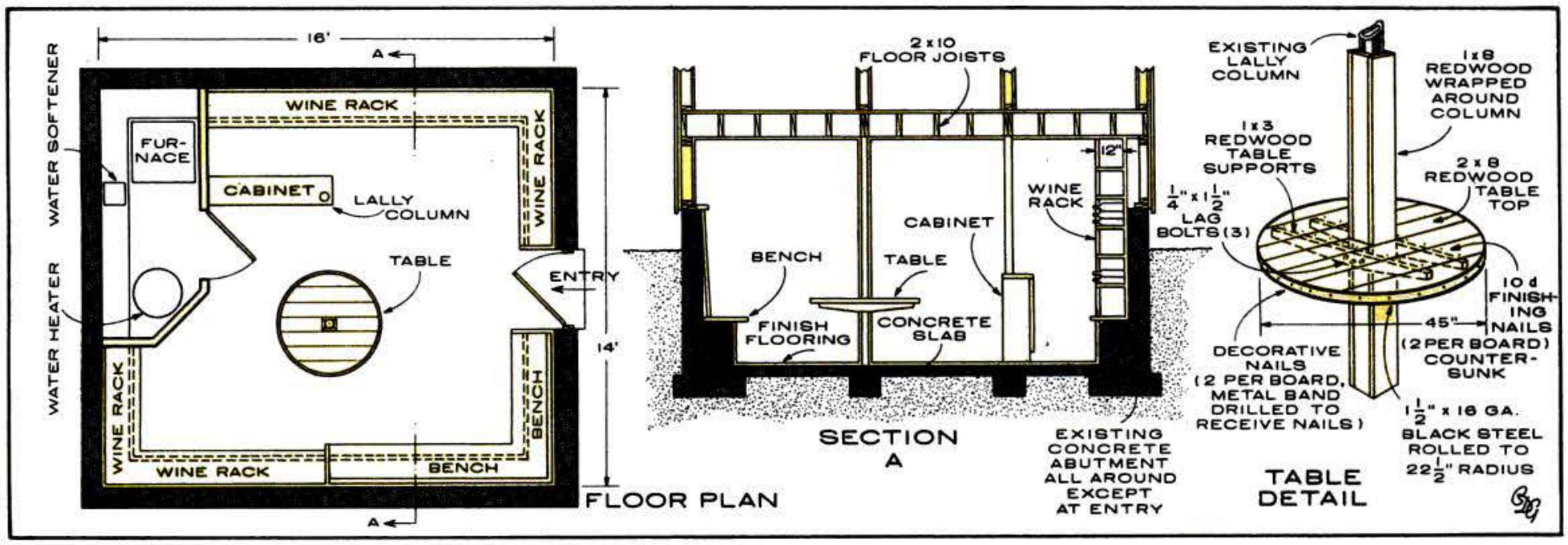
The concrete floor is covered with 12-by-12-in. unglazed terra-cotta tiles mortared in place. The floor joists overhead are covered with tar paper, over which strips of lath are nailed for a trellised effect. Lighting—aside from candles—comes from incandescents in wall sconces. Lights are controlled by dimmer switches.

The only natural light reaching the cellar is through a stained-glass door, which filters the light for pleasant effect and better wine-storage conditions (the less ultraviolet light the better).

Perhaps the cleverest idea is the treatment of the support columns. One is built into a storage divider. The other becomes the support for a small round table where wine and cheese are served.

To add the look of age appropriate to a wine cellar, decorative corbels (cut from redwood) trim the beams, and the redwood throughout is distressed and mellowed with an oil stain.

The basement stays cool, a condition essential for proper storage of wine, thanks to the isolated heating devices. The utility enclosure also helps keep vibrations away from the wine bottles, which store better in peace and quiet. PS



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STORAGE from SCRATCH

Swing-out partition shelves

A storage divider can be hung between garage or basement support posts

By W. DAVID HOUSER

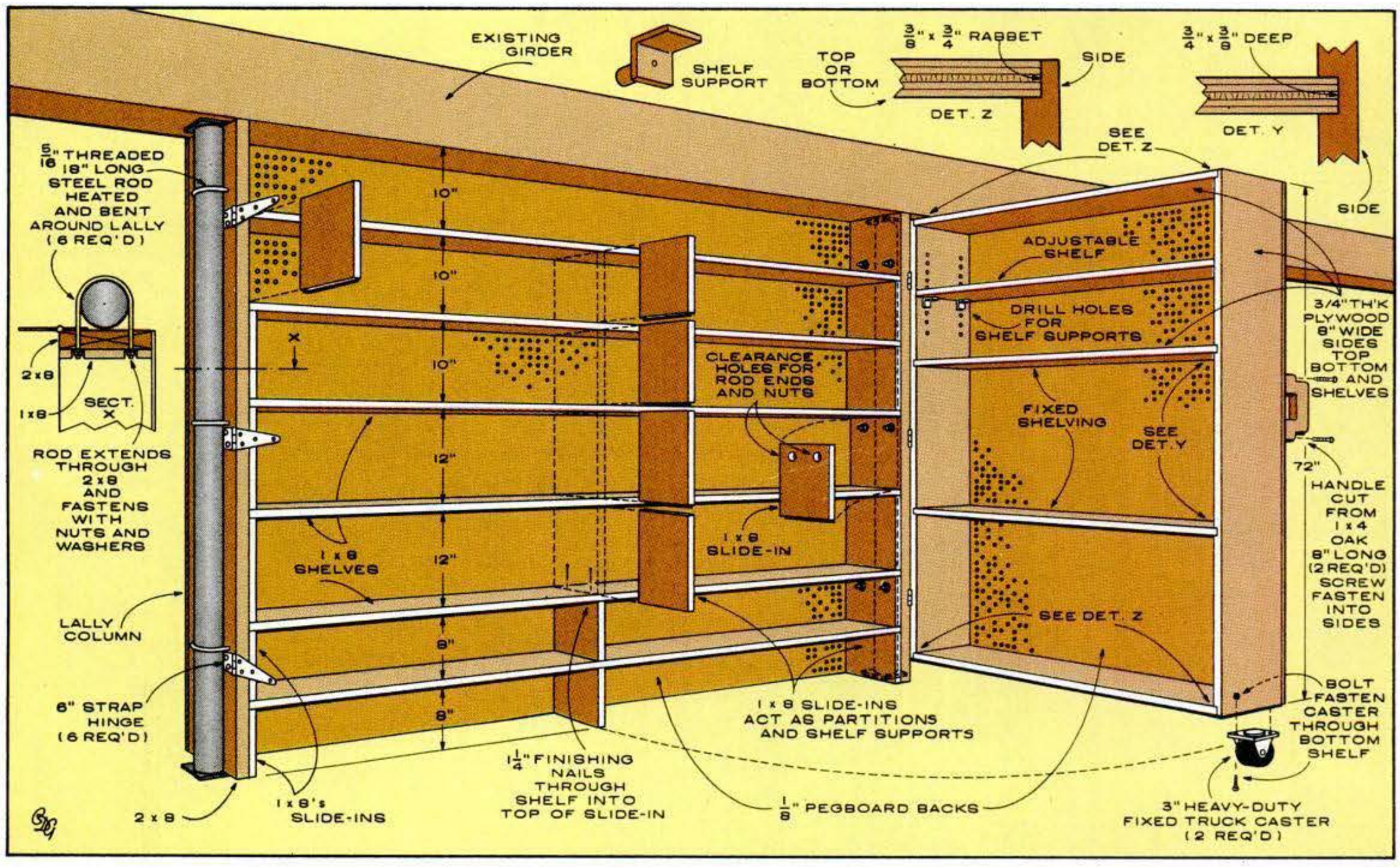
If your house has a pair of Lally columns supporting an upper floor, you can use them to anchor a shelved storage cabinet with a set of swing-out doors. The doors—with adjustable shelves—give you an easy-access, roomy partition unit. Face it with perforated hardboard, and you can use Peg-Board hooks and brackets to hang small items from front and back.

To secure the unit, fasten 2×8's to the support columns with U-bolts. I made mine by heating threaded ⅜-inch-diameter rods with a propane torch to bend them to shape, using the columns as a form. Mark the supports, drill two holes for each rod, then fasten with flat washers and nuts. Use three rods for each side.

Cut the shelving for the stationary section to length. Support each shelf at both ends with uprights of the same stock cut to the desired height. Starting at the bottom, wedge in the shelving supports and shelves successively, supporting the shelves in the center with pieces of the same height nailed through each shelf as it is positioned. On the back, attach sheets of ⅛-inch Peg-Board.

To make the doors, use ¾-inch plywood cut into 12-inch strips for each unit's sides, top, and bottom. Back this frame with Peg-Board and mount a three-inch-diameter wheel on the bottom of each unit. Shelves in the doors can be made fixed or adjustable using any suitable hardware.

Attach the door units with six-inch strap hinges attached at three points along the door's height. PS



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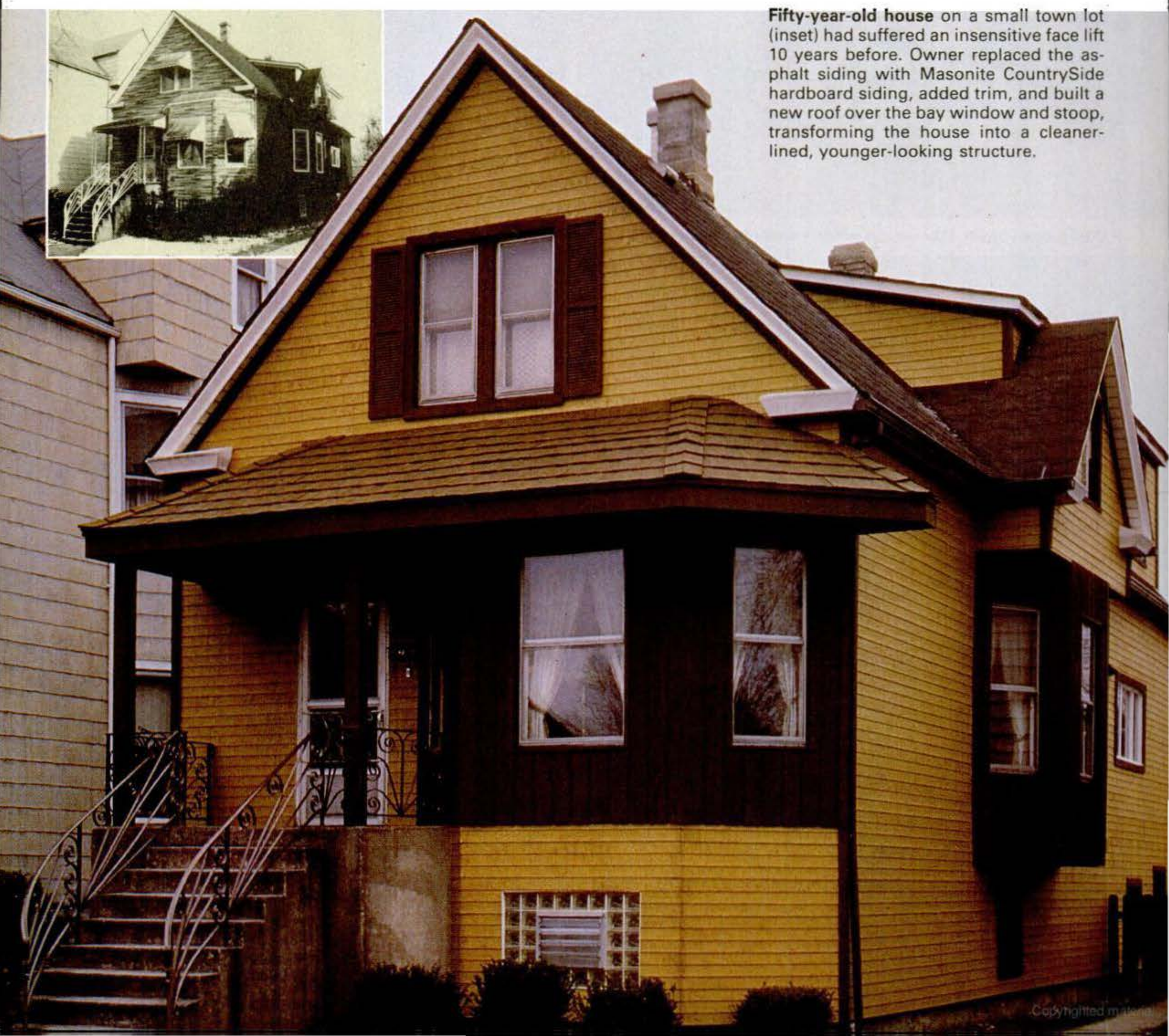
Doors open easily (above) on wheels secured to bottom shelf. Below, Peg-Board on back of the unit is for hanging tools.

Redesign with siding

for a new look—and new thermal efficiency



Fifty-year-old house on a small town lot (inset) had suffered an insensitive face lift 10 years before. Owner replaced the asphalt siding with Masonite CountrySide hardboard siding, added trim, and built a new roof over the bay window and stoop, transforming the house into a cleaner-lined, younger-looking structure.

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Simple structural changes and imaginative use of siding give old houses a contemporary look

By CHARLES A. MILLER

If your house has been mistreated over the years or if you've bought a house that is not quite the match of your dreams (costs being what they are), you've probably given some thought to improving its appearance.

Sometimes that improvement can be achieved with simple re-siding. In combination with a few minor structural touches, re-siding can make an old, nondescript house look new and attractive.

The accompanying illustrations show houses that have been transformed through minor architectural changes plus new siding. These redesign ideas were created for us by two corporations—Masonite and Mastic—to demonstrate ways to use their siding products creatively.

Before you start a remodeling job that involves redesigning, you should first make a detailed plan. Walk around the house and take photos from every possible angle. Have the photos enlarged and mark with a grease pencil any areas that could be improved with simple changes. You could indicate, for example, how the place would look if an old porch were removed, or if a bay window were added to a dining room. Wing walls could be added to increase visual interest (or to block wind from drafty entryways). Shutters, surrounds, windows, and doors are other items you could alter pictorially. Often, adding a new element or deleting a drab feature can make a big difference.

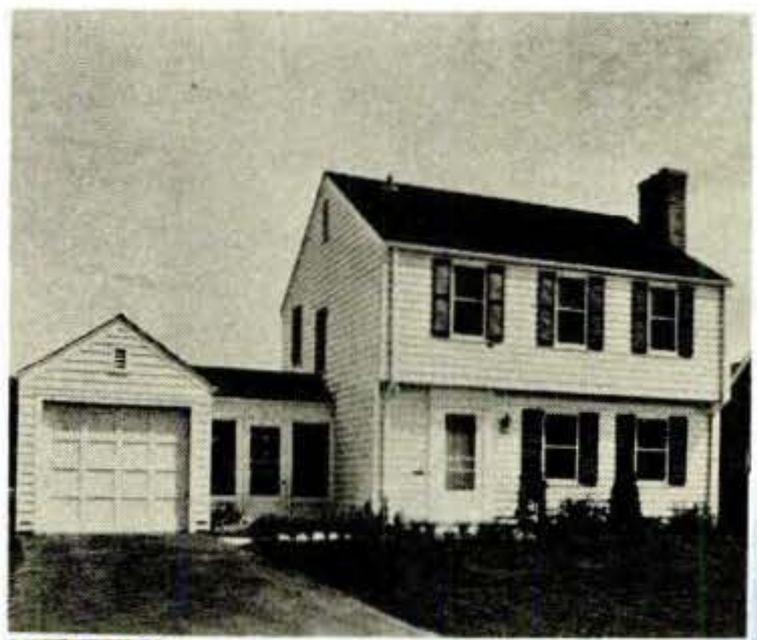
Some other ideas you might want to consider:

- Relocating an entryway for either practical or esthetic effect.
- Replacing an unused or underused door with a window.
- Adding soffits and fascia.
- Changing the arrangement of steps or porches to enhance the overall design.

In our lead photos, the owner of a small house on a city lot changed the appearance of his 50-year-old house by making modifications when re-siding. He added a new roof across the front bay window and stoop. He also added gutters, new window casings, shutters, and trim. Then he chose a gold shade of prefinished hardboard, installed it conventionally, and ac-

Continued

Conventional-looking ranch (right) can be given a contemporary look with a combination of minor changes that add up to an impressive revision: added wing walls, angled siding, new doors and trim, and wood decking. This redesign and the one below were done for PS by Mastic Corp.



Use of different shades of trim, siding, and paint can contribute to a new look. Illustration below shows what a garrison colonial can become if you add wing walls, box beams, a gate, and new fixtures—along with angled application of sections of the siding. Varied colors used for trim accent the alterations.

Starting course of hardboard siding is crucial—it determines positioning of succeeding courses. Initial panel on second course is trimmed to stagger end joints.

Panels are cut to fit around windows and doors. Leave gap (⅛ in., hardboard; ¼ in., vinyl) around openings for expansion and contraction. Gap can later be caulked.

Furring strips frame existing windows to bring new vertical siding flush with casings for cleaner appearance. All deteriorated wood must be removed.

cented the bay windows with vertically applied cedar stained a contrasting brown.

Our two other examples both use vinyl siding. The conventional ranch style was updated by:

- Adding wing walls at the entrance.
- Installing new exterior lighting fixtures.
- Removing the shutters and crisscross muntin bars from the windows.
- Replacing the exterior doors.
- Installing the siding both horizontally and at angles.
- Adding vertical trim boards, covered to match the new siding.
- Including wood decking at each entryway.

The colonial shown was also modernized—using a similar approach. Before the siding was put up, a few cosmetic changes were made to the structure. A wing wall with a round cutout was added to the left of the garage. Other additions went to the right of the garage—connecting the house—and to both sides of the front door, extending the roof. Flat trim pieces were added around doors and windows. Box beams hung between the breezeway and wing walls define a small, gated courtyard. The siding went up both horizontally and at angles. Result: an extraordinary home from a conventional design.

Re-siding can be a do-it-yourself job, especially with hardwood siding. Vinyl siding has been successfully installed by determined homeowners, as well.

The big difference between applying the various materials is that hardboard siding is put up rather like the familiar wood product, with gaps around windows and doors caulked afterward, while vinyl siding comes with elaborate accessories for trimming and flashing; you install it with very little caulking.

Also, installing vinyl siding requires careful attention to cutting, sizing, and nailing because of the inevitable expansion and contraction of the material.

The main thing to bear in mind when installing vinyl panels is that the nails serve to hang the siding—not to fasten it tightly. You must leave room for expansion by not driving nails all the way home; leave them extended by 1/32 inch or so.

The rest is easy

Once the accessories are located properly (which is the most difficult and troublesome part of the job), the task amounts mainly to sawing to length and nailing, letting the trim hide the necessary expansion gaps.

The basic vinyl-installation rules are:

- Don't nail too tightly.
- Don't face-nail; nail in the center of the slots on the nailing hem.
- Leave ¼ inch at all openings.
- Don't pull panels tight—allow them to hang without strain.

As for hardboard, if you've ever installed it *inside* your home, as prefinished paneling, you won't find working with the siding all that different, especially in measuring and fitting. Masonite's CountrySide hardboard offers the advantage of having three four-inch laps molded onto each 12-inch-wide, 16-foot-long piece to make installation faster and easier.

Determining the amount of siding necessary is a straightforward task. You measure an exterior wall's length and width and multiply to find total square footage. You then deduct the area of all windows and doors. For gables, measure length times height and divide by half, again subtracting the area of any windows. It's generally advisable to order slightly more than the exact square footage (10 percent on walls, 15 percent for gables), since there's always a certain amount of waste in cutting for trim and roof lines.

An important part of installation is preparing the walls. Any area—especially around windows—that is mildewed must be thoroughly dried and cleaned. Where wood is badly deteriorated, it must be replaced. If there is no vapor barrier on the interior wall surface, make sure there's adequate ventilation of the wall cavity, especially if you're adding insulation (see box on next page). You'll have to remove shutters, light fixtures, downspouts, railings, and other protrusions from the walls beforehand.

Make sure that the exterior walls are even—not bowed in or out. If they are, they should be made even by shimming or adding furring strips.

With vinyl, a re-siding job centers

Continued

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[*Continued*]

on correctly installing the accessories used to hang and trim the siding. You must be sure that the starter strip, which secures the first course of siding, is level all around—if you misjudge, the top course may not be flush with the soffits. Corner posts have to be plumb.

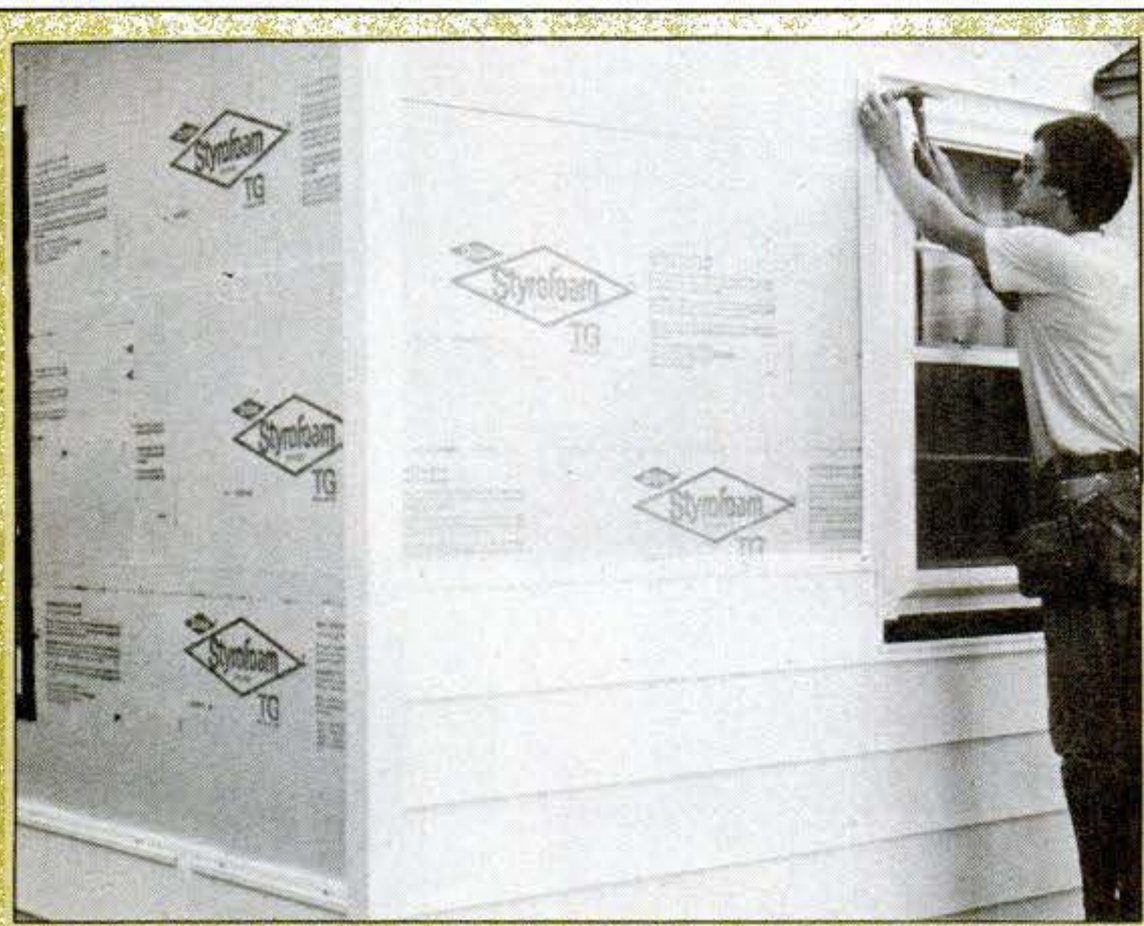
There is an exception, however. If a house has settled an inch or so at one end, taking the windows and other openings with it, level siding may not be appropriate. Siding that's perfectly level when the windows are out of skew doesn't look straight. So if walls are not too far out of plumb, you might find it best to follow the house lines.

If you don't want to take on the job yourself, talk over your design ideas with at least three remodeling contractors to get estimates. They'll probably want to come to your homesite to inspect for special problems. Few siding contractors will tackle architectural changes, such as wing walls—but many will handle a foam-sheathing job for you before putting up the new siding (see sidebar).

Caveats to restyling a house? Be sure that the changes you intend to make are not a hodgepodge—the alterations should come together as a unified whole. Windows should, for instance, be of uniform style. A mixture of double-hung, sliding, and jalousie windows could ruin what should be a simple and consistent design. Be sure that the changes are in keeping with the house's basic lines. If you're at all in doubt, seek guidance from a qualified remodeling architect. PS

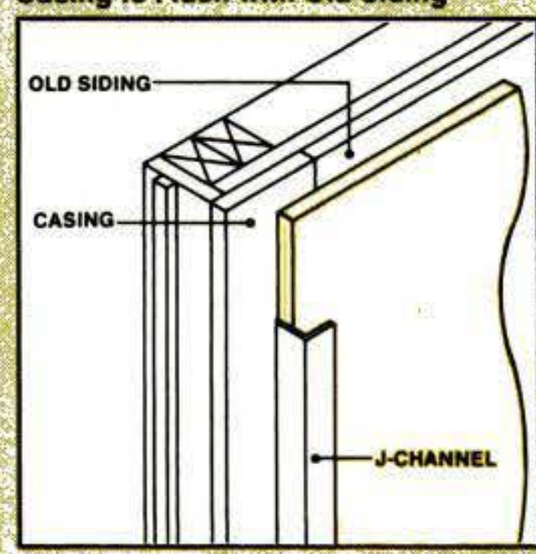
BEFORE YOU CHOOSE YOUR SIDING

Information about remodeling and re-siding may be obtained from the following sources: "A Guide to Designing Your Home's Exterior," Mastic Corp. Information Center, Box F, Berrien Springs MI 49103 ($1); "Your Home Re-siding/Remodeling Styling Guide," Masonite Corp., Box 4436, Laurel MS 39440; "Don't Move . . . Improve!" Alcoa Building Products, Inc., Suite 1200, Two Allegheny Center, Pittsburgh PA 15212; "What You Should Know about Roofing & Siding Before You Build or Remodel," Bird & Son, Leonard Niese, Advertising Dir., East Walpole MA 02032; "What Homeowners Want to Know about Solid Vinyl Siding," Vinyl Siding Inst., 355 Lexington Ave., New York NY 10017; "How to Insulate Frame Walls on the Outside," Dow Chemical U.S.A., Styrofoam Products, 2020 Dow Center, Midland MI 48640.

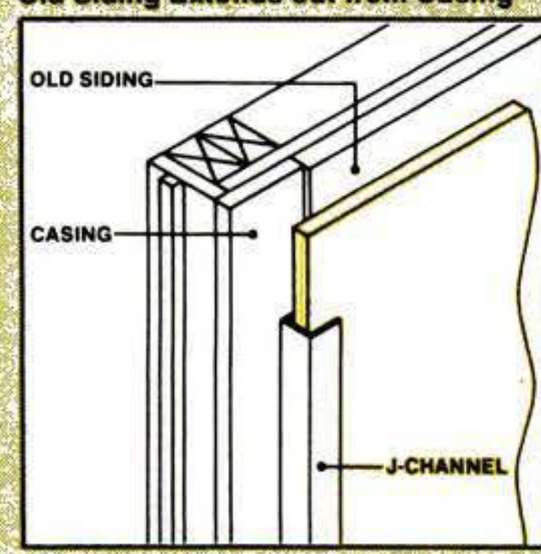


Re-siding provides an ideal opportunity to upgrade insulation

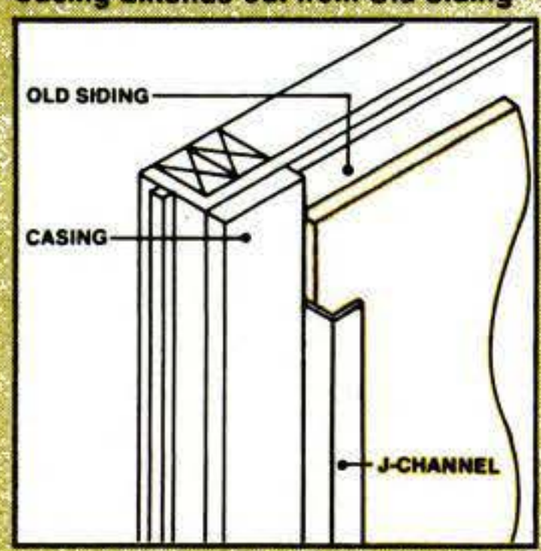
Casing Is Flush with Old Siding



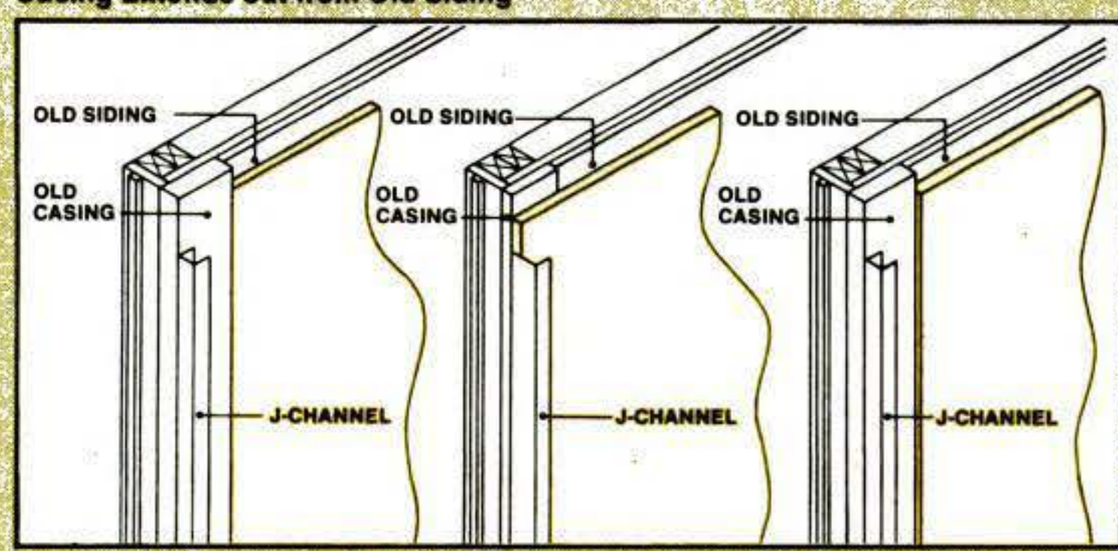
Old Siding Extends out from Casing



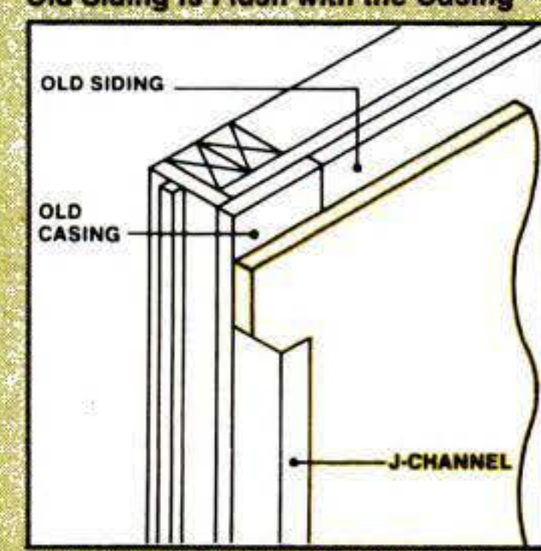
Casing Extends out from Old Siding



Casing Extends out from Old Siding



Old Siding Is Flush with the Casing



Adding insulation to the walls of your house can be a problem. It's relatively easy to add to an attic or crawl space, but, short of rebuilding or blowing in fill, there's little you can do to retrofit a wall. However, if you're planning to re-side, a golden opportunity presents itself.

One of the easiest ways to increase a wall's R-value when re-siding is to use rigid-foam boards such as Styrofoam or Thermax. But there are problems. The biggest headache is bulking up trim around windows and doors to compensate for the increased surface thickness. You must also bulk up trim at inside and outside corners and at the roof line. Fortunately, these areas can be trimmed with relatively little trouble using accessories such as extra-width aluminum J-channel, corner posts, and molding—standard siding items available at many siding distributors, home centers, and lumberyards. In some cases a distributor may be able to provide you with custom trim fabricated from standard aluminum stock.

Installation tips? When nailing the foam boards, use only three to five large-head nails per board. Nail in a random pattern. The new siding should be nailed through the boards, penetrating at least 1½ in. into the wall studs. The foam boards are not a nailing base.

Use J-channels around window casings as illustrated in the accompanying drawings. When there is a slight recess (¼ in. or less) between the old siding and casing, run the foam boards over the casing for better insulation. Caulk any gaps.

If there is no vapor barrier on the wall's warm side, you'll have to ventilate the cavity properly. Drill ½-in. holes through the old wall from the outside at the top and bottom of each stud cavity.

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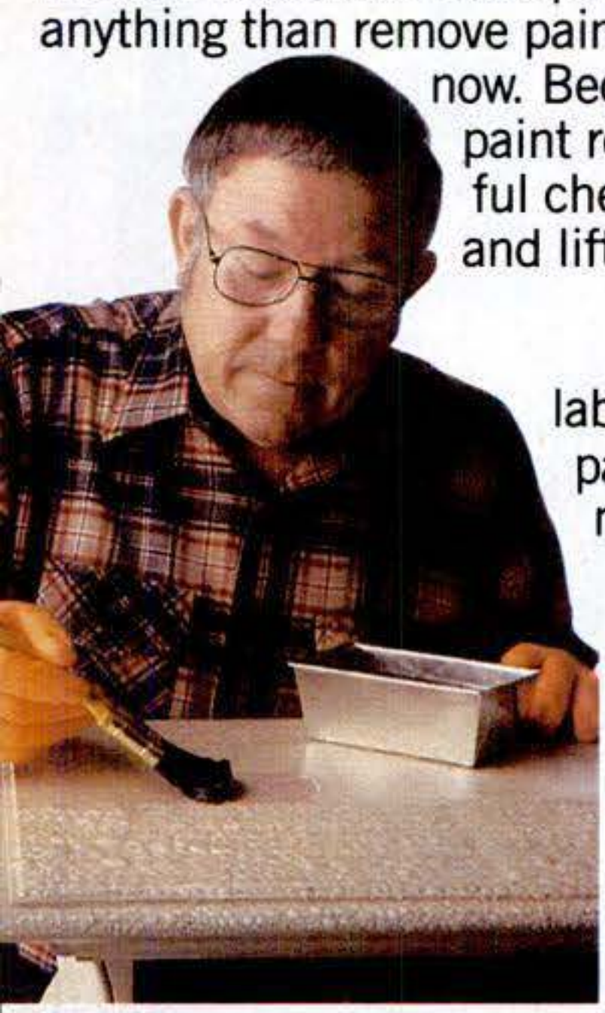
Homer Formby Says:

"Paint removing sure needs improving."

All the scraping and sanding. All the misery and mess. No wonder most people would rather do almost anything than remove paint. But that's all changed now. Because I've developed a new paint remover built around powerful chemicals that loosen and lift.



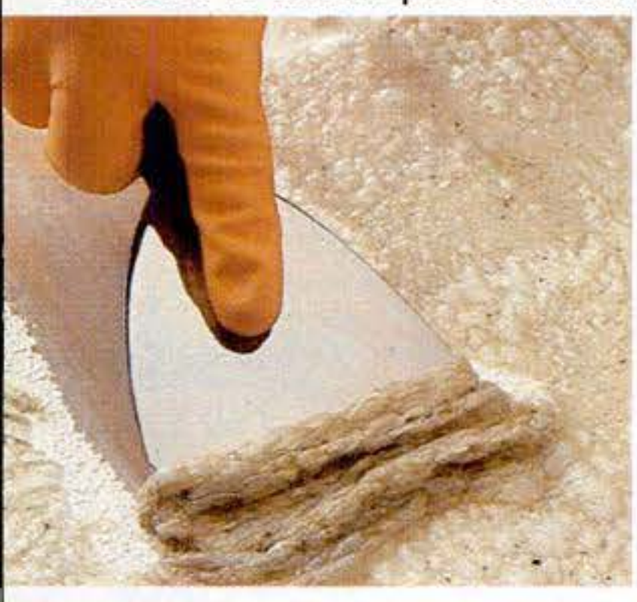
Tests Show It's Best.

In fact, an independent laboratory just tested my paint remover, and found it more effective than other leading brands.

My Paint Remover can remove virtually any kind of paint. From any kind of wood.

Remove Years of Paint in Minutes.

Brush on Formby's® Liquid Paint Remover and you can actually watch the old paint layers being bubbled away. It's that effective because my special wood formula is a unique combination of premium ingredients that plow through paint. And it's heavybodied, so it works fast and holds tight. Making it easier to work on vertical surfaces.



And less scraping means you're less likely to gouge the wood. Importantly, my formula won't harm the surface.

The Paint Remover Wash Removes Residue.

But I didn't stop with a Paint Remover. I developed a Paint Remover Wash to remove any residue. This step also prepares the surface for the finishing or staining.

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Sometimes you simply can't brush on paint remover. So that's why I developed my Aerosol Paint Remover. I believe it's a revolution.

Imagine the same penetrating power as the liquid, but in a convenient spray that gives perfect coverage on places like legs, moldings, and carvings.

After 50 years of brush-on paint removers, my spray ushers in a new day.

"I Love Wood."

Wood has been a part of my life ever since I worked as a boy in my father's antique shop, hand-rubbing fine furniture.

I believe in letting the natural beauty of wood shine through. My paint remover gets through years and layers of paint to reveal the glory of the wood underneath.

So take on those projects you've been putting off. With Formby's® Paint Remover. It takes the pain out of paint removing.

For more information on Formby's® Paint Remover, and other Formby's® products, write to Formby's Inc., P.O. Box 667, Olive Branch, MS 38654.

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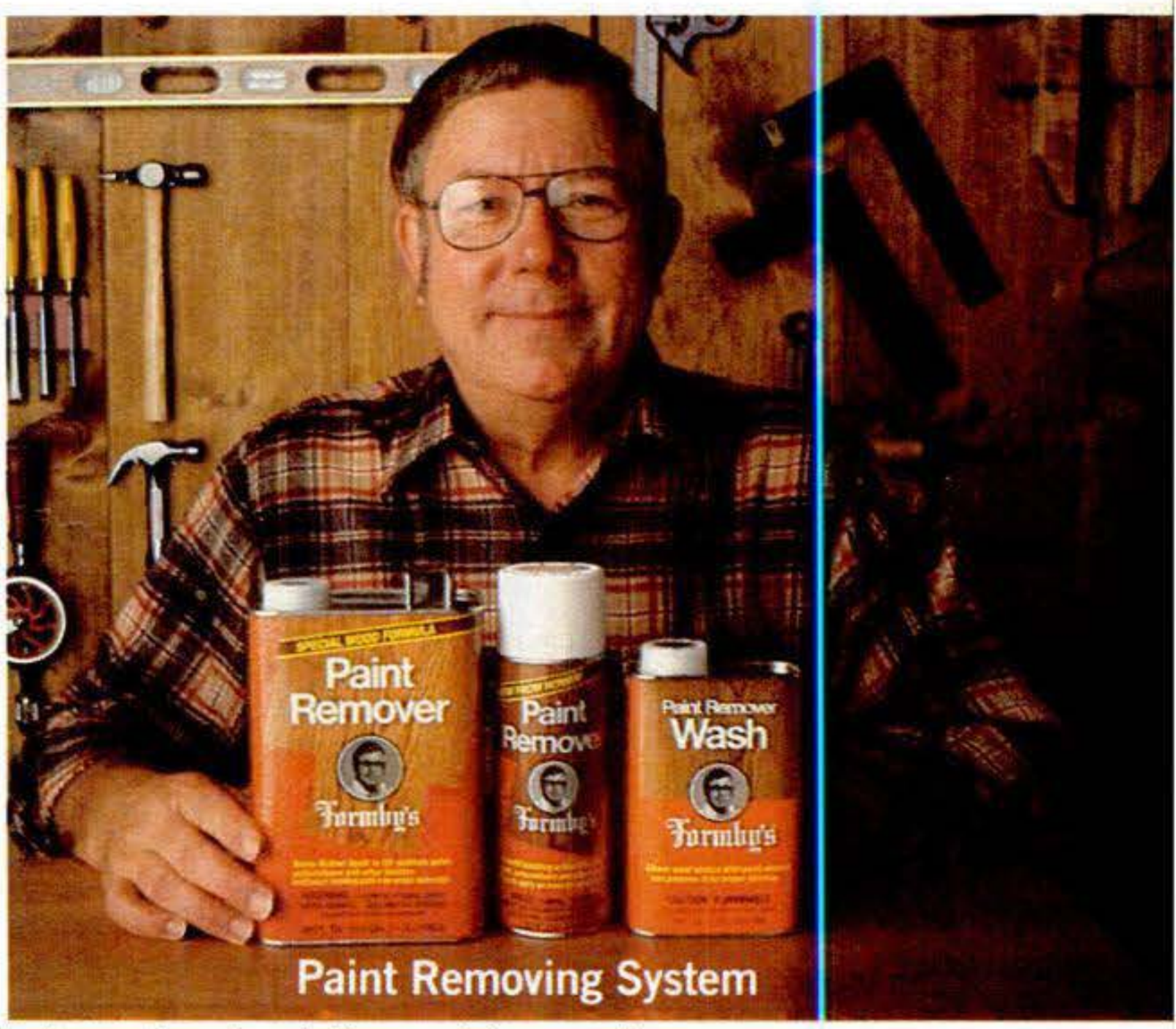

Formby's products are available at better paint, hardware, department stores and home centers.

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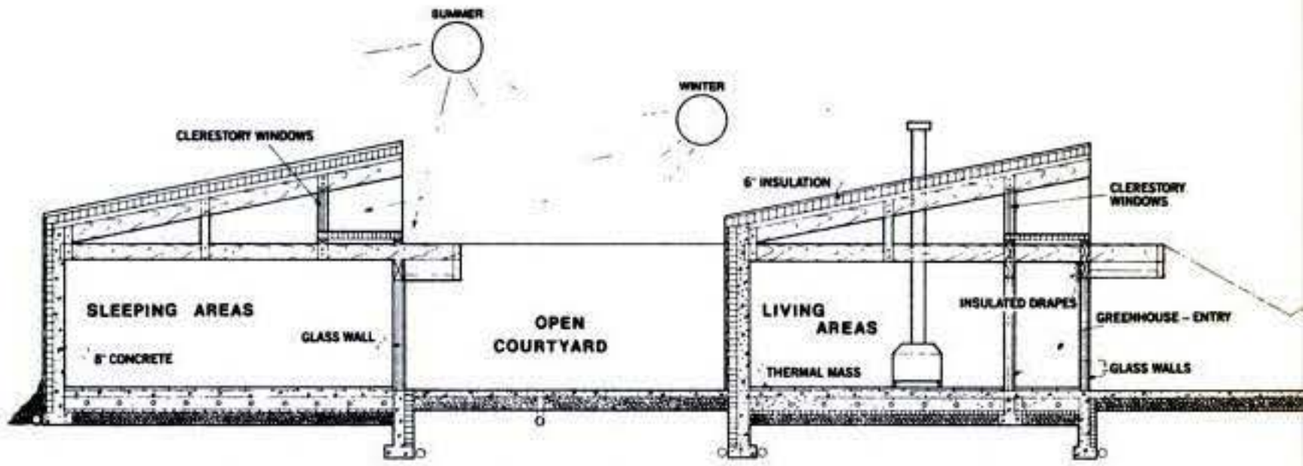
PS leisure-home plan

Earth-sheltered atrium



Compare this labeled section with cutaway color perspective above it to see how courtyard separates three bedrooms from the living areas that face the street and—ideally—due south. Overhangs and trees shade glass areas from high summer sun.

By AL LEES RENDERINGS BY RANDOLPH PADORR-BLACK

For the third consecutive September we include, in our home-improvement issue, a new design by "underground" architect Charles G. Woods. His first plan for us, in 1980, drew the largest response in the 10-year history of our leisure-home series. And last year Woods shared with PS readers plans for the earth-sheltered home he was constructing for himself in the Pennsylvania mountains. I have since visited him there and can attest to the livability of a Woods design.

What you see in the color illustrations above is the architect's most ambitious home for us to date. Many people I've shown the main rendering to have taken it for the world's first underground motel. Actually, a bit of artistic license has been taken to dramatize the central-atrium feature. The floor plan at right details an area of about 2,060 square feet, so the rendering is somewhat overscaled to afford a peek into that courtyard that supplies light and air to the rear bedroom section. (The artist has even taken the liberty of shifting the hall access door to keep it visible in his bird's-eye rendering.)

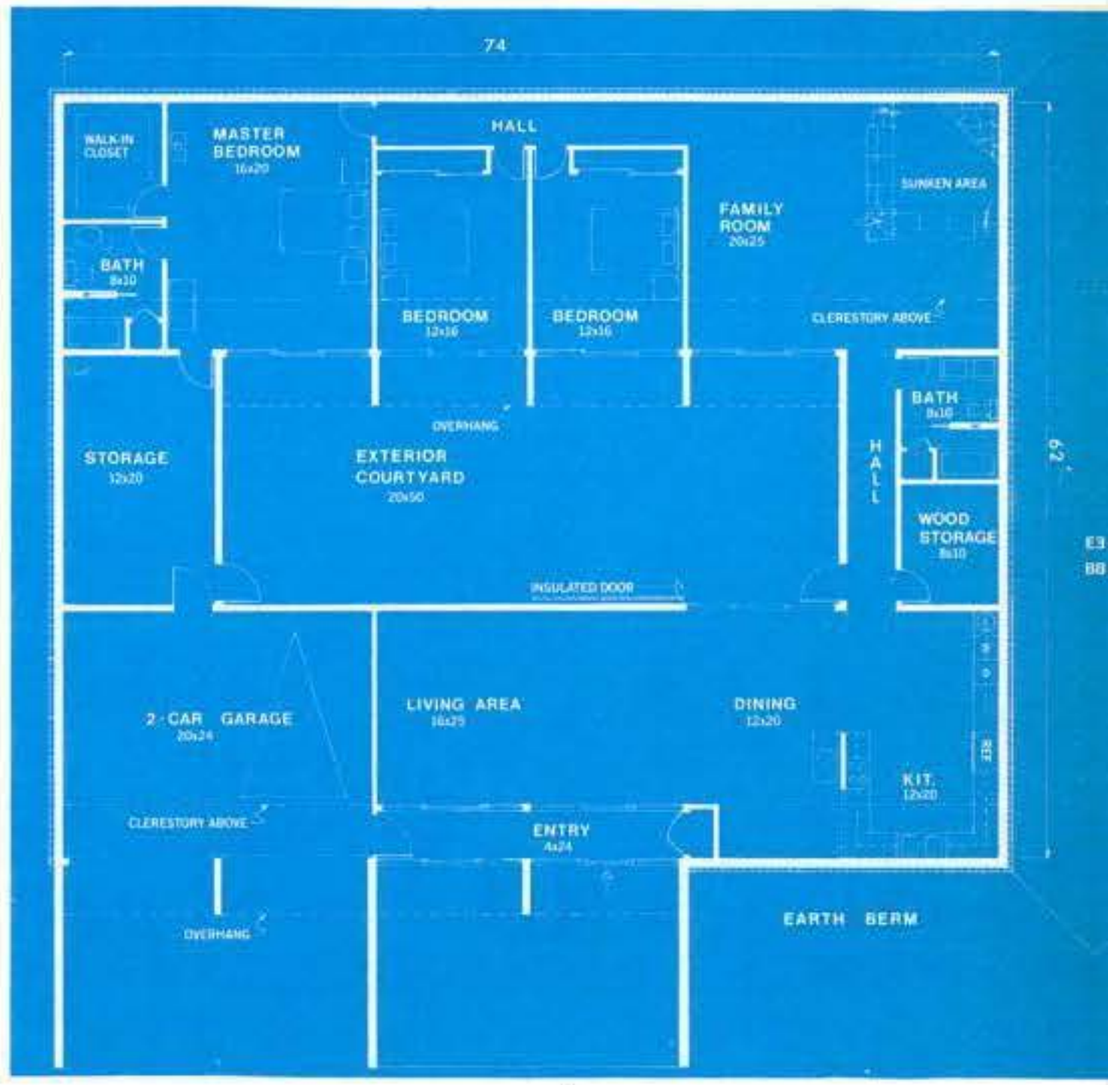
What isn't shown is an insulating panel that moves—on a barn-door track—to cover the major courtyard access: a sliding glass door from the dining area. If all major windows, including the recessed clerestories that march the full width of both sections, are sited to the south, this dining-area glazing would face north and (since it would receive no direct sunlight) would create a heat loss during winter nights. The back face of the insulating shutter can be given a colorful mural treatment so it becomes a design element beyond the glass when it is closed and no access to the courtyard is needed (this is not solar glazing).

Woods calls this his "zero-energy" house since it's a direct-gain passive solar design, with exterior walls almost fully wrapped round with a tall earth berm. Notched into a south-facing slope, the house offers a front garage and airlock entry at ground level. The entry is glazed on both long walls to create an attractive and energy-efficient greenhouse adjacent to the living room. The low winter sun literally floods all interior spaces with light and warmth through the ground-floor window-walls and double-glazed clerestory windows. The heat gained from all the south-facing glass is stored in the thick thermal mass of the masonry floors and walls.

The inner court lets Woods keep all major glass areas facing south without having an excessively wide house. The structural system is post, plank, and beam on a 12-foot module, so lengthening or shortening the house by 12-foot increments is relatively easy. Since there are few interior bearing walls, room arrangement can be altered to suit the owner-builder's needs.

All windows are equipped with insulating drapes or shutters, and the exterior walls are super-insulated. Back-up heating is by wood stove and circulating fireplace—augmented by hot-water radiant heating in the floor. If the insulating covers for the windows are properly used, the house should need up to 95 percent less heat than a traditional home.

The roofs are to be covered with sheet metal, and the plans detail various waterproofing procedures. Anyone contemplating building this or any other earth-sheltered house will want to check our feature article in next month's issue on recommended construction techniques. PS



How to order plans for this house

One set of working drawings costs $100; each additional set ordered at the same time is $15. Make your check payable to Charles G. Woods and mail to him at Natural Architecture, R.D. 3, Box 538, Honesdale, Pa. 18431. Allow three weeks for delivery. Plans for the two previous houses by Woods are still available from the same address.

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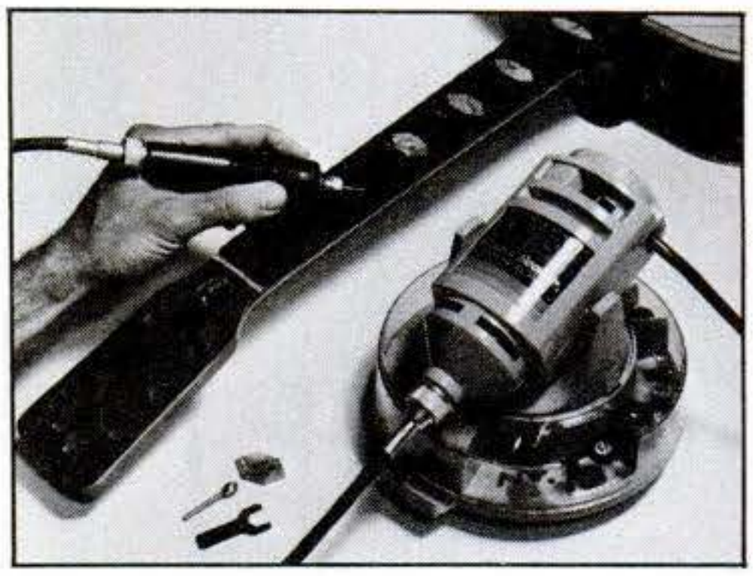
Hobby Shop
is many-in-one tool



I've always classified a flexible-shaft tool as a frivolous replacement for tools I already own. But not anymore. This Black & Decker Rotary Hobby Shop doesn't just eliminate the need for chisels, jeweler's saw, files, sanding blocks—it's a tool that's easier and faster to use. I found it to be perfect for delicate work—well suited to any number of jobs.

To do just one job—replace the frets and two fingerboard inlays on a guitar—I used the Hobby Shop for a total of six different operations. I used a grinder to remove two old inlays, then switched to an engraving bit to deepen and enlarge the recesses. After that, I cut out two inlays from sheet abalone using an abrasive cutting disc. Once the inlays were in place, I smoothed them down flush using a self-adhesive sanding disc. That same disc then dressed the ends of the replacement frets. Finally, I polished the frets smooth with a miniature buffing wheel.

The tool has a variable-speed motor you can set to suit the job. Usually the top speed of 19,000 rpm is best, but the slower speeds are useful when you want to make precise cuts.

The flexible shaft is extremely pliable (some I've tried are so stiff they fight you), and the hand piece is free of vibrations so you can maintain good control.

The Hobby Shop comes with a starter selection of accessories (more are available from Black & Decker) and will accept any of the 1/8-inch-shaft accessories made by Dremel and Foredom.

Of course, this isn't the kind of tool you'd use every day. But when you put it away, all the accessories store with it—in a rack built into the base. Price: $60.—*A. J. Hand*

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What makes this radar detector so desirable that people used to willingly wait months for it?

Anyone who has used a conventional passive radar detector knows that they don't work over hills, around corners, or from behind. The ESCORT® radar warning receiver does. Its uncanny sensitivity enables it to pick up radar traps 3 to 5 times farther than common detectors. It detects the thinly scattered residue of a radar beam like the glow of headlights on a dark, foggy road. You don't need to be in the direct beam. Conventional detectors do. Plus, ESCORT's extraordinary range doesn't come at the expense of more false alarms. In fact, ESCORT has fewer types and sources of false alarms than do the lower technology units. Here's how we do it.

The unfair advantage

ESCORT's secret weapon is its superheterodyne receiving circuitry. The technique was discovered by Signal Corps Capt. Edwin H. Armstrong in the military's quest for more sensitive receiving equipment. ESCORT's Varactor-Tuned Gunn Oscillator singles out X and K band (10.525 and 24.150GHz) radar frequencies for close, careful, and timely examination. Only ESCORT uses this costly, exacting component. But now the dilemma.

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At the instant of contact, how can you tell a faint glimmer from an intense radar beam? Is it a far away glint or a trigger type radar dead ahead? With ESCORT it's easy: smooth, accurate signal strength information. A soothing, variable speed beep reacts to radar like a Geiger counter, while an illuminated meter registers fine gradations. You'll know whether the radar is miles away or right next to you. In addition, the sound you'll hear is different for each radar band. K band doesn't travel as far, so its sound is more urgent. ESCORT keeps you totally informed.

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ESCORT looks and feels right. Its inconspicious size (1.5Hx5.25Wx5D), cigar lighter power connector and hook and loop or visor clip mounting make installation easy, flexible, and attractive. The aural alarm is volume adjustable and the alert lamp is photoelectrically dimmed after dark to preserve your night vision. And, a unique city/highway switch adjusts X band sensitivity for fewer distractions from radar burglar alarms that share the police frequency while leaving K band at full strength.

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Another nice thing about owning an ESCORT is that you deal directly with the factory. You get the advantage of speaking with the most knowledgable experts available and saving us both money at the same time. Further, in the unlikely event that your ESCORT ever needs repair, our service professionals are at your personal disposal. Everything you need is only a phone call or parcel delivery away.

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Corroborating evidence

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PENTHOUSE . . . "ESCORT's performance stood out like an F-15 in a covey of Sabrajets."

AUTOWEEK . . . "The ESCORT detector by Cincinnati Microwave . . . is still the most sensitive, versatile detector of the lot."

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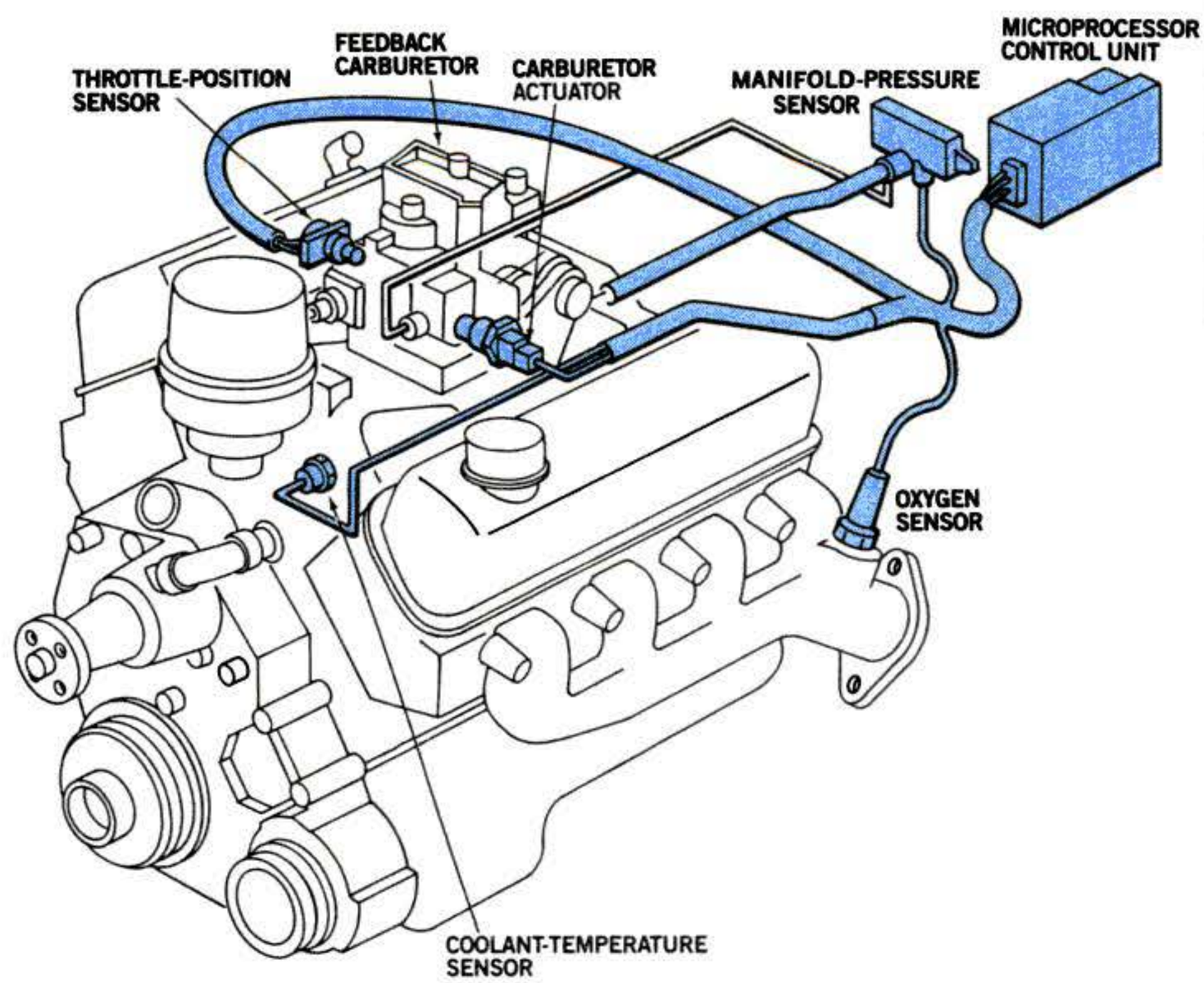
THE THINKING MAN'S GUIDE TO CAR MAINTENANCE

By TOM WILSON and RICHARD DAY

Feedback-carburetor systems

The FEEDBACK-CARBURETOR system



The microprocessor is the brain behind the feedback-carburetor system. Heart of the computer: a tiny silicon chip. It's programmed to change air-fuel mixture based on data received from various sensors. Thus the carburetor is "fed back" information from the computer, and the system is interactive. All this occurs only when the engine is in the cruising (closed-loop) mode. During cold start-up and certain other conditions, the computer is deactivated and the system works on a preprogrammed, slightly richer mix.

How do they work?

Everywhere you look these days, computers are controlling things. The automobile is no exception. If you have a newer car, it may well have an electronic control system. And unless it has fuel injection, one of the computer-controlled components will be the feedback carburetor.

In the late 1970's auto makers began installing electronic control systems to monitor and regulate various engine processes. One of these processes, carburetion, is particularly tricky because the carburetor ideally should vaporize gasoline at a 14.7:1 air-fuel ratio to minimize emissions. Even the most complex conventional carbs aren't as precise as they should be to meet today's strict standards. Enter the feedback carburetor. It receives signals from various sensors via the computer control unit (hence, feedback) and provides a nearly perfect air-fuel mixture. However, electronically controlled carburetion is an evolving technology, and each of the "big three" car manufacturers has approached it differently. The operating details are unique to each system.

Can you service the highly sophisticated feedback-carb systems? In general, if you can read a voltmeter and clip on jumper wires, you can. One of your most important resources will be the factory shop manual. It is essential as a reference tool, and without it you'll be lost. Because these types of electronic systems are so complicated, we can only explain the general principles involved with what you'll do.

Continued

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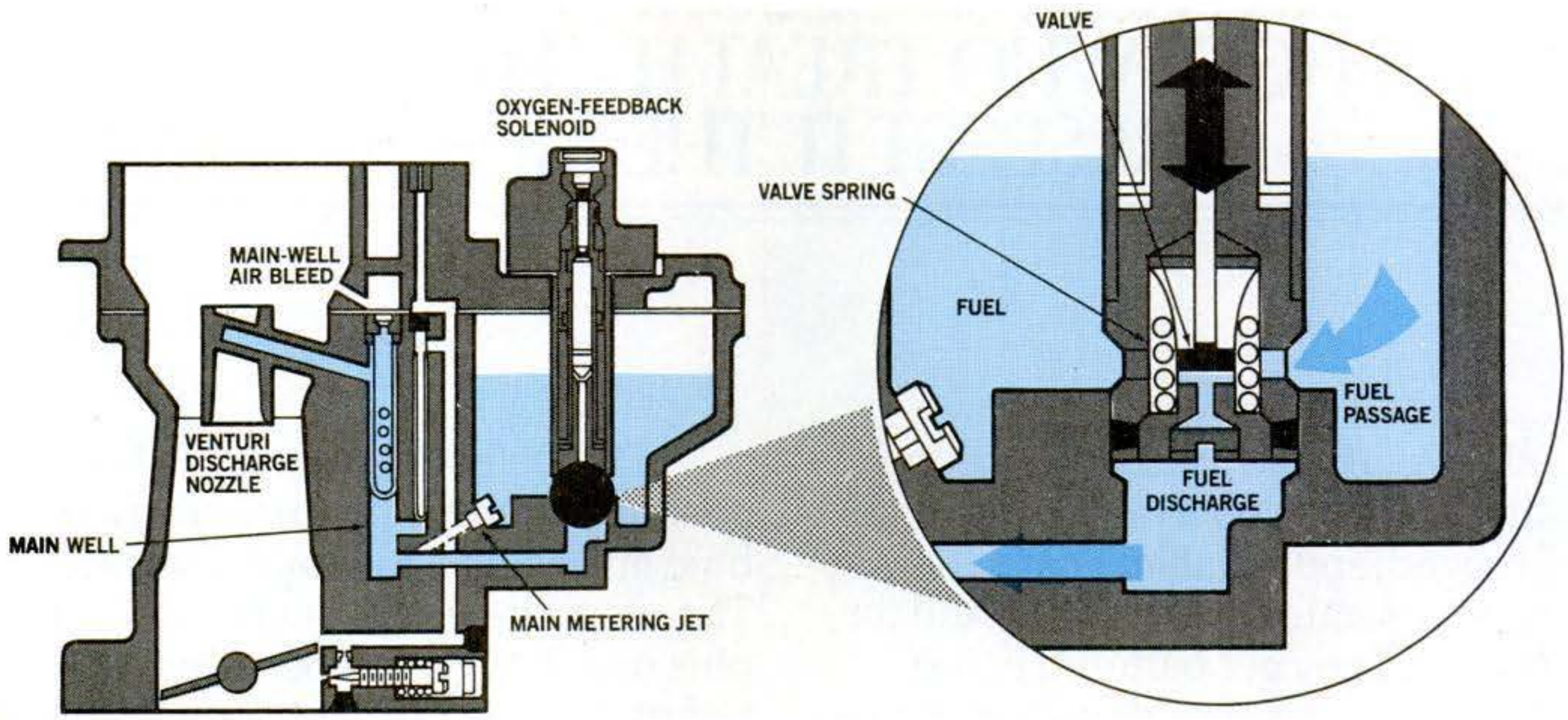

Chrysler's electronic oxygen-feedback solenoid works in conjunction with a conventional fixed main metering jet. When power is off, the valve spring holds the valve open, allowing richest mixture. With power on, the valve is pushed down to close off the opening, giving leanest mix for any air flow. By controlling power-on time fuel-air ratio is regulated between the extremes. Some Chrysler feedback systems are operated by a vacuum regulator valve instead of by a solenoid in the carburetor. (General Motors' solenoid is connected to the carburetor's metering rods; the stepper motor in Ford's carb has 120 positions and is updated 10 times a second.)

For detailed information, the service manual is an absolute must. You'll also need a hand vacuum pump and the usual timing light, vacuum gauge, fuel-pressure gauge, and hand tools. Thus armed, you'll be ready to service your carb.

System basics

The interactive feedback-carburetor systems work only during the "closed-loop" mode. Closed loop is a term indicating that the sensors, computer, and carburetor are working with each other. The electronic signal in a closed-loop system originates at the oxygen sensor, which continually sniffs out the oxygen content of the exhaust gases and converts the percentage of oxygen into an electrical signal. A lean (oxygen rich) mixture yields a low sensor output of about 0.1 or 0.2 volt. A rich (oxygen starved) mixture makes the sensor generate a higher voltage, with an upper limit of 0.6 to 0.8 volt. By measuring oxygen levels, the sensor indirectly measures the air-fuel ratio.

The electrical signal travels from the oxygen sensor to the control module, a small computer with the ability to receive signals and send commands to various components based on information received. During the closed-loop mode the microprocessor receives the oxygen sensor's signal along with similar signals from sensors that measure coolant temperature, barometric pressure, manifold pressure, throttle position, and possibly other conditions. The computer monitors all incoming information and decides whether to enrich or lean out the air-fuel mixture.

To make a change in mixture, the computer sends a signal to a solenoid or stepper motor on or inside the feedback carburetor (see drawing above).

All this occurs in the closed-loop mode. Under some conditions, such as cold starting, hot idling, and wide-open throttle, the system works in the "open-loop" mode, which means that the microprocessor is ignoring its signals from the oxygen sensor. Instead it is giving the carburetor a preprogrammed command for a slightly richer mixture.

Feedback-carburetor systems are simple in theory. All the complicated parts are in the computer, sensors, and carburetor. Servicing the systems requires testing to find the defective part. You can't repair much; replacement is the usual fix.

When it comes to actually doing the work, check the rest of the engine before doing anything to the carburetor. If the car idles roughly, for instance, do a compression check and make sure ignition timing is right on. Give all vacuum hoses the once-over, paying special attention to their ends, which can dry out and crack. Be sure all electrical connections are clean and tight, and check all grounds: Complete circuits are important to a feedback system because of the extremely low voltages involved. With only 0.2 volt there's none to give away at a loose or dirty connection.

To give you an idea of what to expect when you tackle your feedback carb, here's a look at the three major auto makers' systems, each of which requires a different procedure.

GM's talking computer

General Motors' C-4 system is a sophisticated microcomputer-controlled setup that serves both the fuel and ignition systems. One of its major advantages is its easy-to-use self-test capability. Once the self-test circuit is energized, all you need to do is count the flashes of the engine light on the dash. The flashes will indicate any one of 13 system-problem code numbers, which can be deciphered using the shop manual.

If your car's CHECK ENGINE light comes on or the engine runs poorly, begin testing by activating the self-test circuit. To do that, you must first locate the computer: It's under the dash (passenger side) in air-conditioned cars, behind the passenger-side kick panel in others. Once you've found it, check over its wiring loom until you locate an unattached green connector hanging from a black-and-white wire. With the engine off, ground this lead using a jumper wire. Now watch the CHECK ENGINE light; it should show a "12" code by flashing once, pausing, then flashing twice in succession. The 12 code will flash unless other problems are detected or until the engine is started. This code means that there is no tachometer signal going to the computer, which makes sense since the engine isn't

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running. If the light does not flash, either the wiring or the microprocessor is bad. Every time you ground the test lead, check for a 12 code; then you'll know the self-tester is working.

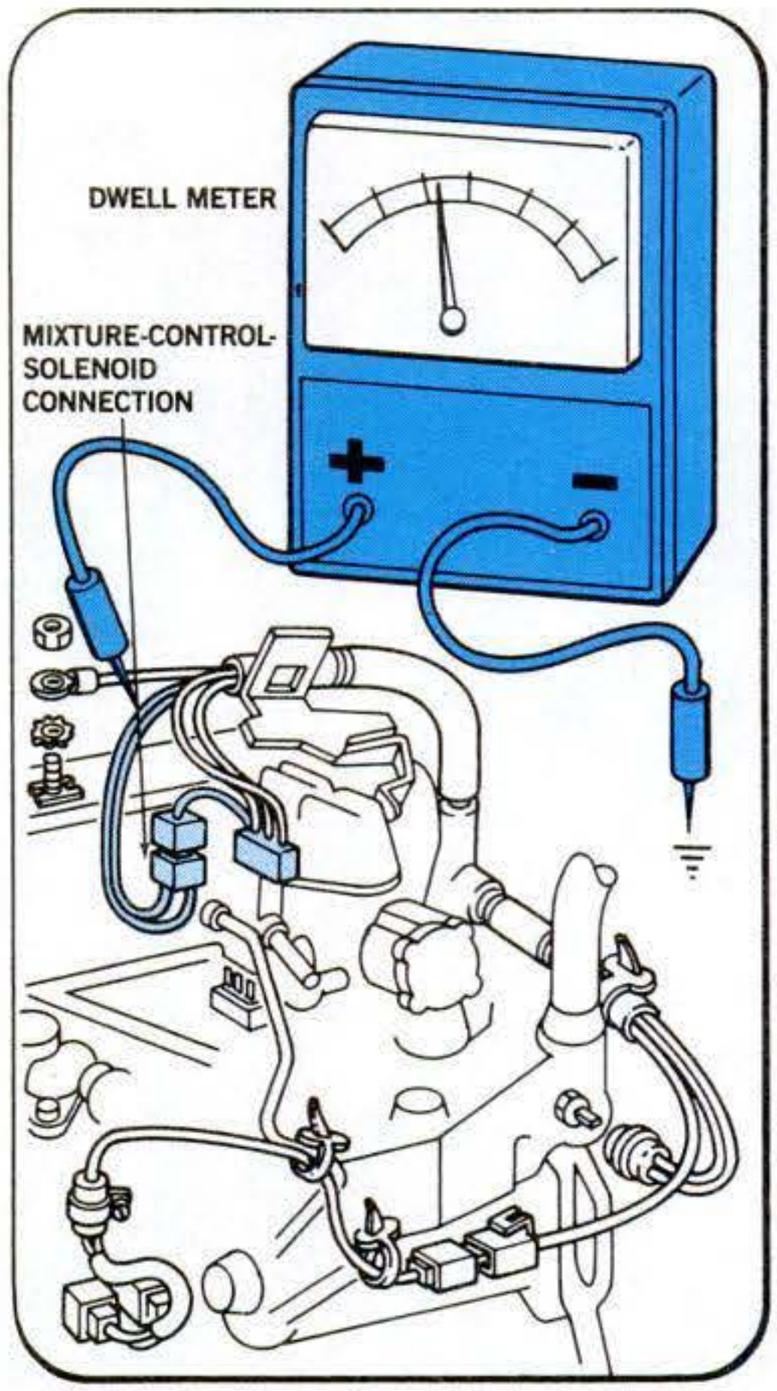
Now disconnect the jumper and start the engine. Reconnect the wire and watch the light. It will flash one or more codes three times each.

Normally the microcomputer has short-term memory: It will recall applicable trouble codes from when the ignition was last switched on. Once the ignition is turned off, short-term memory is erased. If a 21 code flashes each time the ignition is turned on, for example, the shop manual will tell you there's something wrong with the throttle-position-sensor circuit.

But perhaps you're trying to corner an elusive, intermittent problem: Sometimes the trouble code flashes, sometimes it doesn't. The "talking" module can be be your best friend because it has the ability to remember for long periods, too. To connect the long-term memory a wire must be run from the battery to the s terminal on the computer. GM has made this connection easy by running a wire from the terminal to a four-terminal end, which can be found under the dash just left of center. There's one open space in the connector; this is where you clip your hot jumper wire. With battery power to the s terminal, long-term memory is actuated, and turning the ignition off and on no longer causes the microprocessor to forget. You can run the car for days until you're sure the intermittent problem has struck, then you ground the green connector to get the flashing code.

Some cautions apply when making a long-term connection. First, make sure that the 12-volt jumper-wire supply isn't switched—the memory will erase if power is switched off. Second, letting the car sit for long periods with the long-term memory actuated could result in a dead battery.

Using long-term memory may often be more convenient than running a short-term test because some codes take up to eight minutes of running at 1,500+ rpm to complete. It's easier and faster to connect a hot jumper to the long-term memory before work on a Friday morning than to waste time and fuel warming the engine on Saturday to refresh the short-term one.



Dwell meter is making a comeback with GM's C-4 system. The computer sends on-off signals, which the meter can read, to the mixture-control solenoid. Connect the dwell meter to the solenoid's "dwell" lead using a six-cylinder scale; watch for between 10 and 55 deg. of "dwell." Any needle movement indicates the system is working—no need for system testing.

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Since 1980, some GM C-4 systems have been delivered with the long-term memory connected. All you do is disconnect the wire temporarily after you've made repairs to erase the memory.

Feedbacks from Ford

Ford has two computer systems: the simple MCU and the octopus-under-the-hood EEC III. If it's a high-tech, comprehensive system you're looking for, the EEC III is it. With seven sensors, the computer is housed in two boxes and commands five systems besides the feedback carb. A self-test program is included, but it can't be run without the Electronic Engine Control System Tester ($1,500).

The MCU system is less comprehensive than EEC III (it controls air-fuel ratio and EGR), but you *can* tap into its diagnostic program to find out what's wrong with the feedback-carb system. Unlike GM's C-4, though, you'll need an analog voltmeter (needle type) to read it. An under-hood connector is provided for the negative voltmeter lead. The positive lead goes to the battery's positive post. A few vacuum connections and disconnections are necessary, the carb's fast-idle cam must be on its lowest setting, and the PCV valve must be removed. The 15 codes are read on the 16-volt-DC scale as a series of voltage surges. A 41 code (lean air-fuel ratio), for example, will show as four surges followed later by one surge. The first test is done with the engine off, then a running portion is next with up to 20 possible codes. Secondary checks of the pinpointed problems are then made, many with a VOM.

If the test code says that the oxygen sensor is constantly giving rich signals, you could figure on a bad sensor, faulty sensor wiring, or malfunctioning carburetor actuator. Several voltage and ohm checks later, you'd know just where the problem was. Following the test sequence with a shop manual will lead to the culprit.

Chrysler's silent system

The Chrysler system is simpler than either GM's or Ford's, but no self-test feature is available. All performance checks, which are detailed in the shop manual, must be done with a VOM, vacuum pump, and other standard test and tuneup tools.

Chrysler has simplified checking out its system by breaking down the trouble-shooting procedure into four categories: visual inspection, no-start, cold-engine drivability, and warm-engine drivability. Obviously, if your car starts and warms up well but stumbles when warm, for instance, you need only follow the visual-inspection and warm-engine-drivability procedures.

One example of Chrysler's step-by-step method is the one for the oxygen sensor. The shop manual shows a green wire, which you need to connect to a voltmeter, leading from the carburetor. Instead of breaking a connection, use a fine needle or pin to pierce the wire's insulation, then wrap the hole with electrical tape when you're done. Now connect the voltmeter's positive lead to the pin; connect the other lead to a good ground. Start the engine and let it run at 2,000 rpm. Close the choke plate and hold it down; within 10 seconds the voltmeter should read a steady three volts or less. If it doesn't, disconnect the PCV system. Voltage should rise to a steady nine volts or better. If the sensor fails, you'll have to replace it.

It's a lot of simple tests such as these that make up feedback-carburetor service. If you can find your way through a standard carb and have basic tuning skills and the proper factory manual, you'll be able to handle your computerized carburetor. PS

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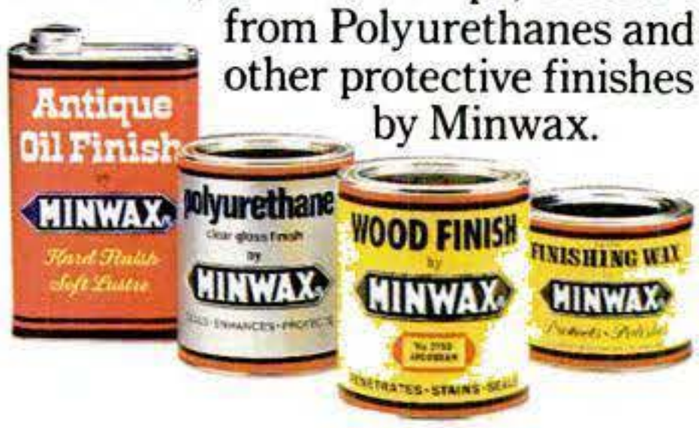

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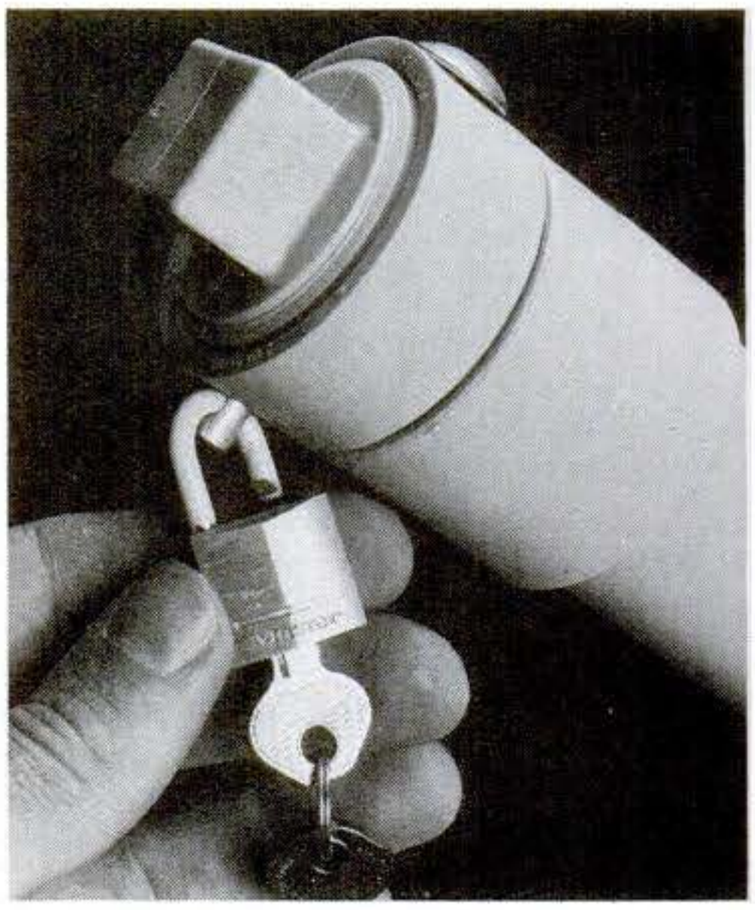

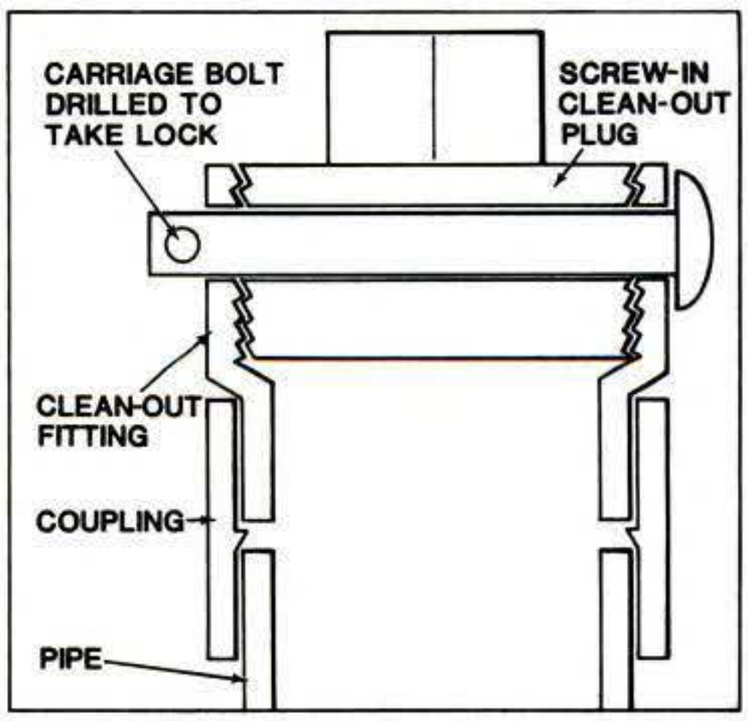

With a few inexpensive fittings, some pipe cement, and a carriage bolt, you can turn a length of 1½-in. PVC pipe into a sturdy lockable fishing-rod case.

Onto one end of the pipe, glue a PVC cap. For the other end fashion a threaded removable cap using a coupling cemented onto the pipe, into which you cement a clean-out fitting.

Next, thread a clean-out plug into the fitting and drill a 5/16-in. hole through both the fitting and plug. File the fitting hole square to accommodate a carriage bolt's shoulders. Now drill the carriage bolt to accept a small padlock. Cut off the threaded portion of the bolt and file the end smooth.

You secure the case by slipping the bolt through the hole in the plug and fitting, then locking the padlock through the bolt.—*A.J. Hand*

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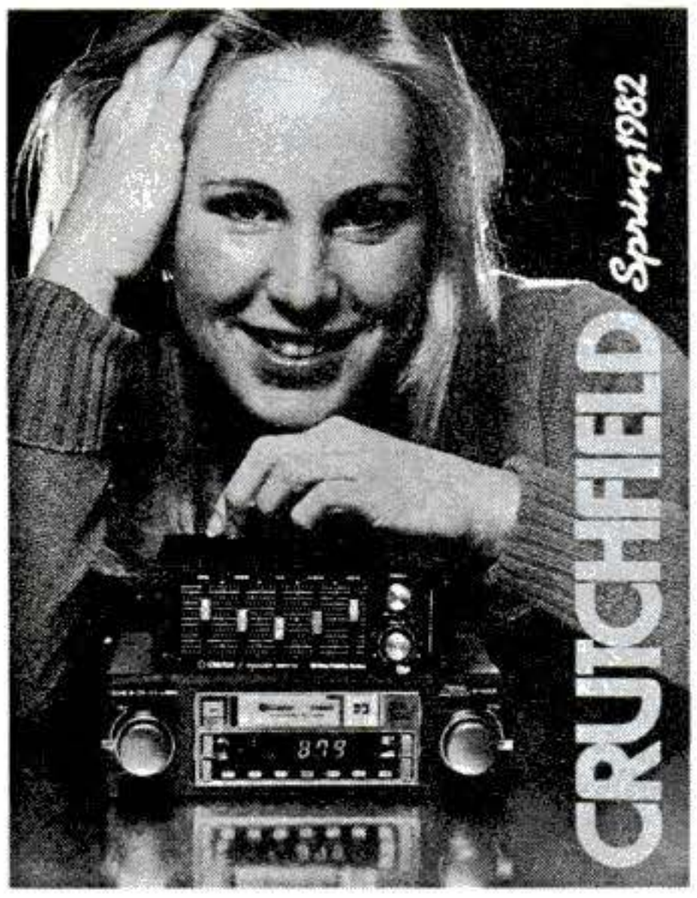

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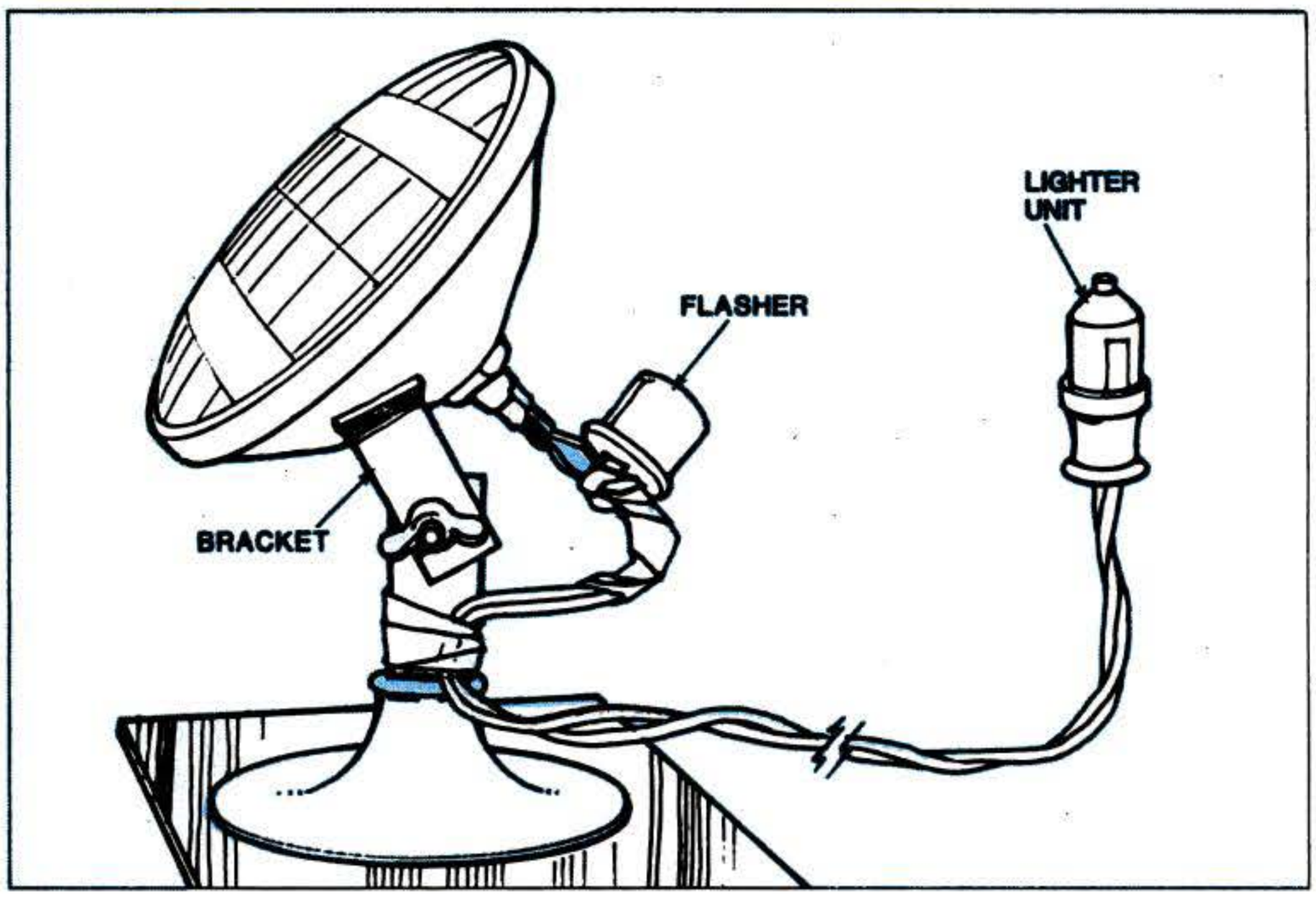
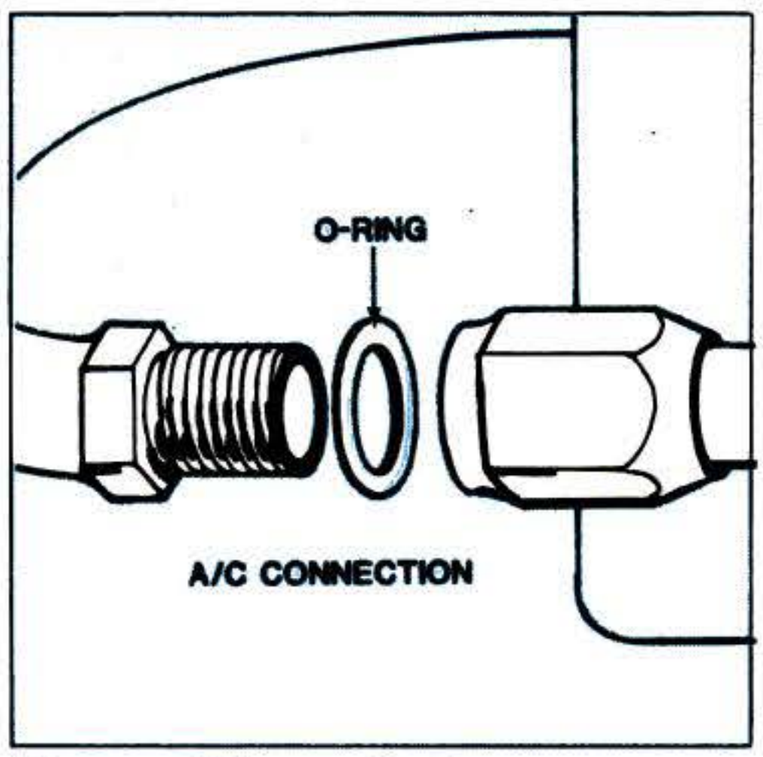


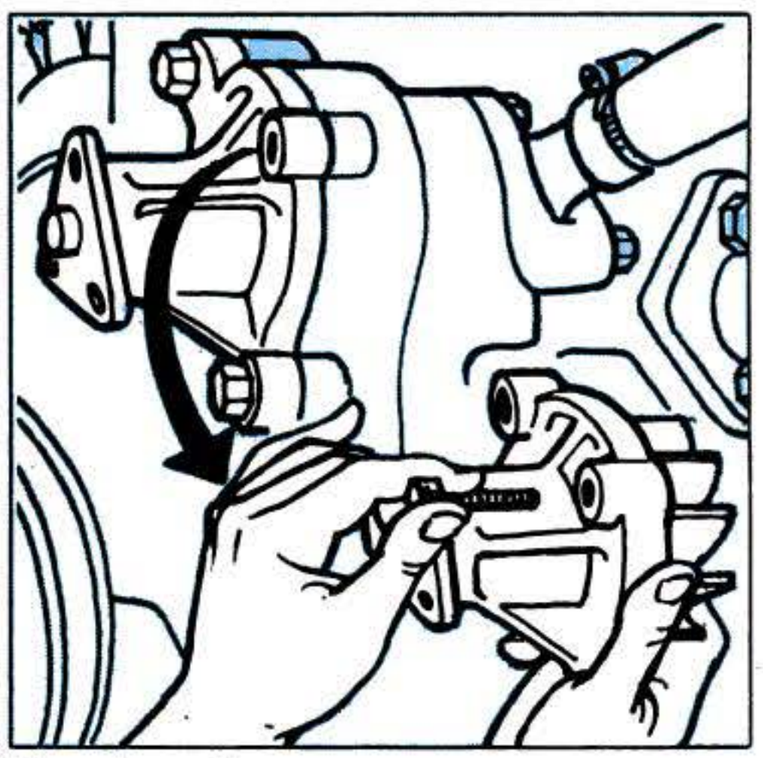
Clever trouble light with a powerful beam

Need a handy lamp to shed some light on your automotive problems? This one is based on an ordinary sealed-beam headlight unit. Using epoxy cement, attach a bracket directly to the back of the lamp. Then secure a second bracket to the first with a wing nut to help you adjust the beam angle precisely. A rubber suction cup on the end of the second bracket allows you to secure the powerful light to the car's roof or trunk, or even upside down. Two 14- or 16-gauge wires approximately 25 feet long are then hooked up to a cigarette-lighter unit and the lamp connections. You can add a turn-signal unit if you want an emergency flash feature.



Air-conditioner O-rings

Many air-conditioning systems use special O-rings to seal connections. Whenever a system component is removed for service or replacement, new O-rings should be installed. To ensure a tight seal, coat each ring with refrigeration oil. (Note: Do not leave the oil container uncapped or it will absorb moisture from the air.) This will prevent mysterious leaks that may require a recharge of R-12.



Handy reference

Retaining bolts are often incorrectly reinstalled when parts are replaced. To avoid that, as you remove bolts from the old part, put them in their corresponding holes in the new one. When the old part is out, transfer the retaining hardware from the new part to it. Then position the new component and install the bolts, using the old part as your guide. It's simple and eliminates assembly confusion.

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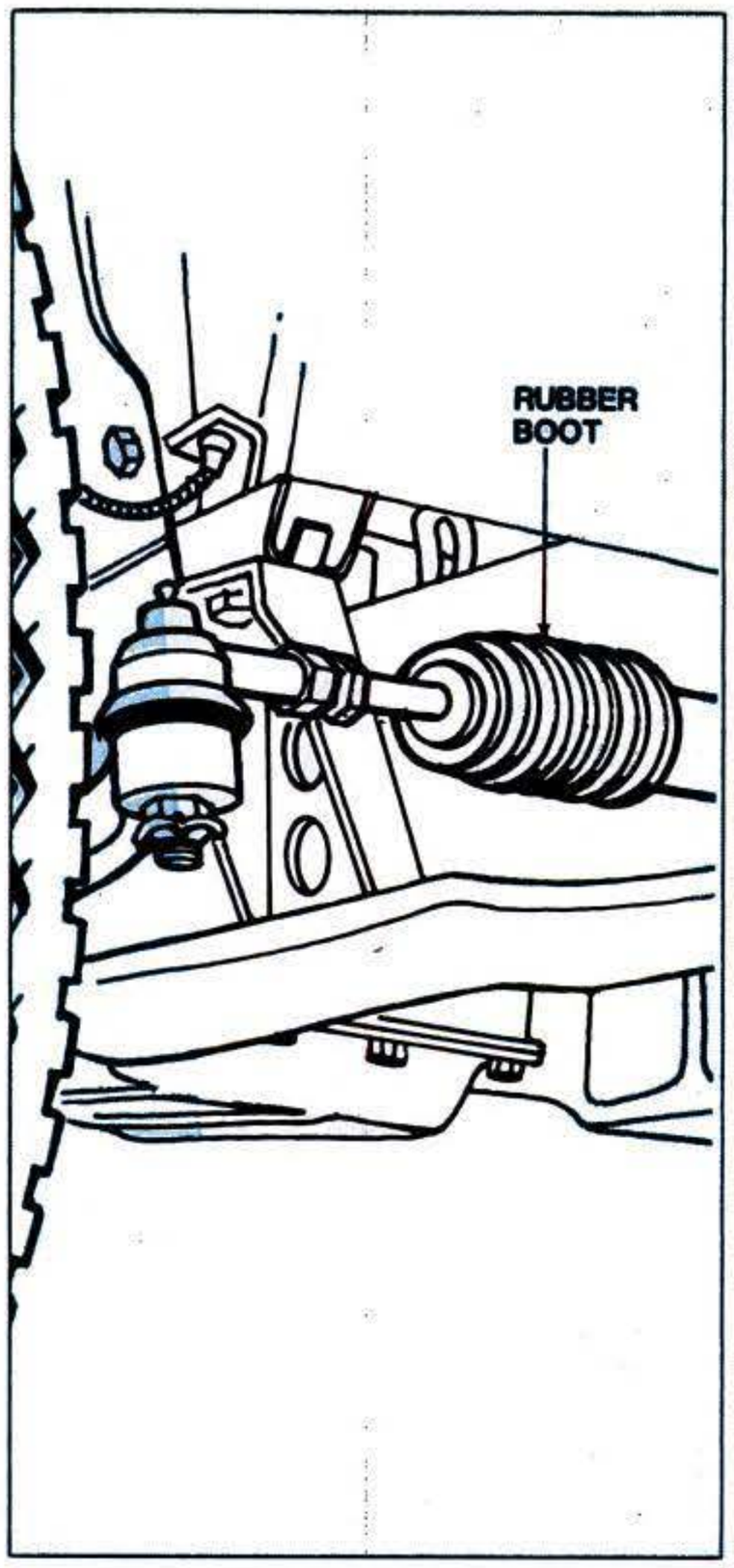
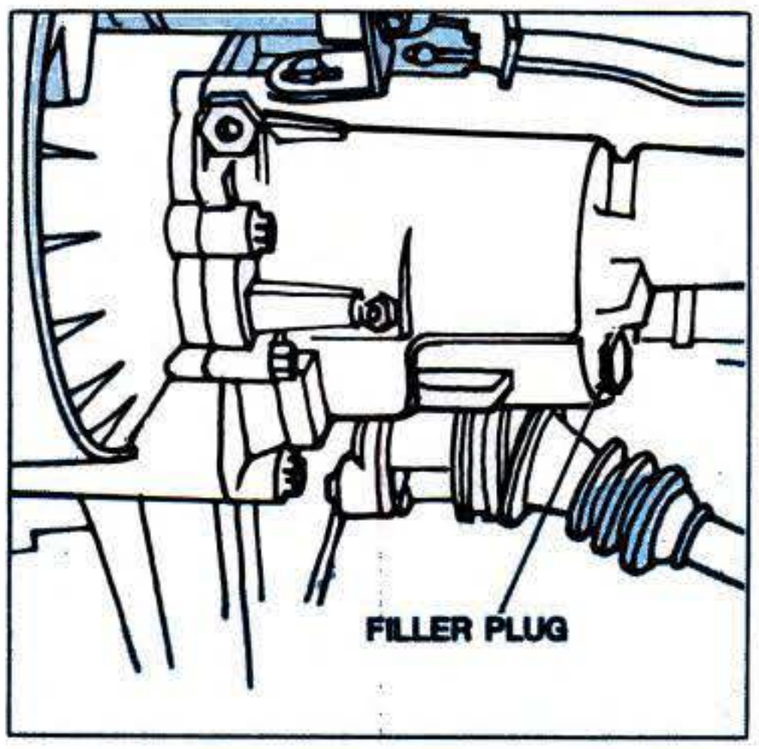


Steering-rack-boot inspection

The bellows boots on a rack-and-pinion steering-gear assembly should be checked periodically. First, look for lubricant leaks. Then twist each boot and look for tears or cracks. Replacing a damaged boot is not difficult; follow the shop manual. If the boot isn't replaced, dirt will eventually damage the assembly.



Manual transaxle-lube check

To check the lubricant level in a manual transaxle, follow these simple steps. On a flat, hard, level surface, raise and support both the front and rear of the vehicle. Be sure the transaxle is cool. Next, slowly remove the filler plug from the case. The lubricant level is correct if the fluid is even with the lower edge of the filler hole. Refill if necessary, using only the specified type of lubricant for your car.

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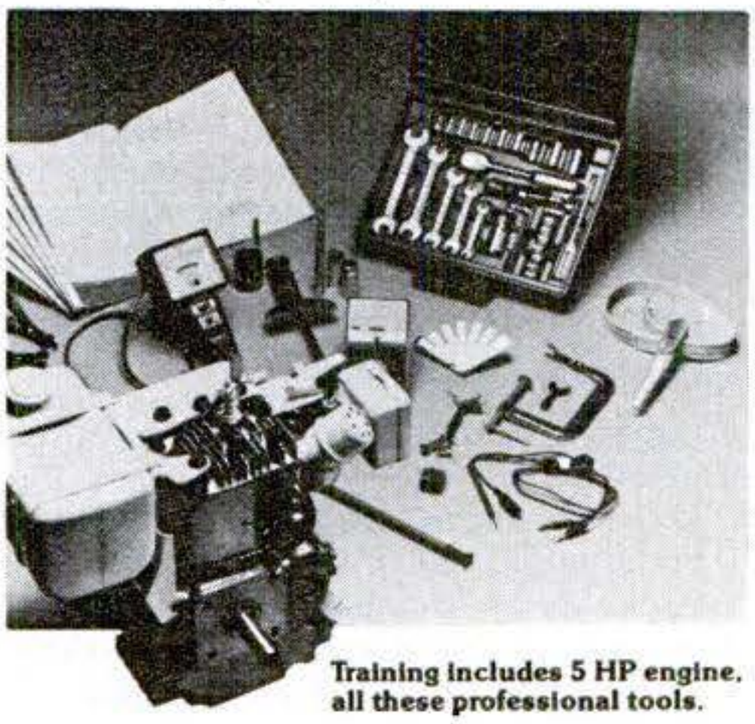
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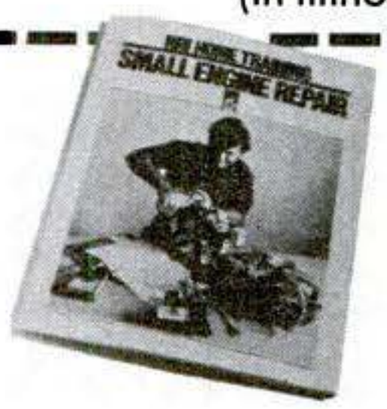

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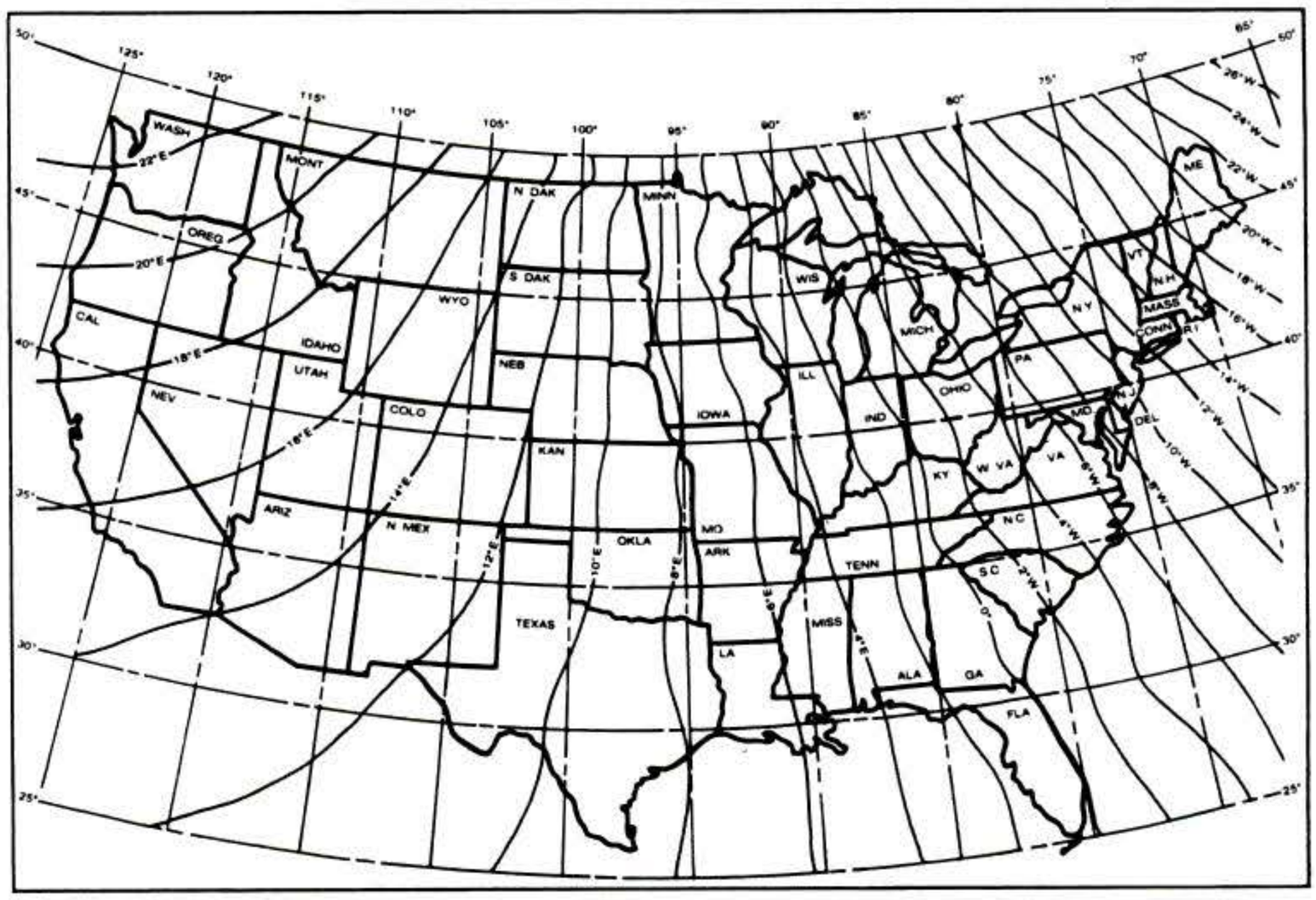
ALTERNATE-ENERGY ANSWERS

By JAN F. KREIDER

Jan F. Kreider is a consulting engineer specializing in the design and economic analysis of solar-energy and energy-conservation systems. He is the author of several books on solar technology, and a lecturer at the University of Colorado.



Two kinds of north

Would you please give me an explanation of magnetic north versus geographic north and how you determine the latter?

Joseph Kaye, Uniondale, N.Y.

Determination of geographic, or "true," north and south is important when aligning solar collectors, especially focusing, tracking types. True north is the direction toward the north pole of the Earth's rotational axis. Magnetic north is the direction toward the pole of the planet's magnetic field, located in northern Canada, and is the direction a compass needle points to. The angle between the lines from any point on the Earth's surface to the magnetic and geographic north poles is called the magnetic declination. It can be read for locations in the continental U.S. from the map above. For example, the map shows a line labeled "12°W" passing through New York's Long Island, where reader Kaye lives. That means the north needle of a compass points 12 degrees west of true north in Uniondale.

Physics of sunlight

I often read that a solar collector or photovoltaic cell is *x* percent efficient. Since solar collectors use the sun's heat and photovoltaic cells use the sun's light, does that mean there are two sources of energy from the sun? Also, how much energy can be delivered by the sun on one square foot under ideal conditions?

W. C. Crane, Millburn, N.J.

There is only one source of energy from the sun, but there are several ways to convert it to useful energy. Solar energy is electromagnetic radiation that is propagated through space to Earth. It can be thought of as streams of particles, called photons, traveling in waves at the speed of light (the wavelength is dependent on the level of energy). In itself, solar radiation is not useful as energy, but when intercepted by a surface on Earth, it excites particles in the surface to higher energy levels. If a dark surface is used, much of the sun's energy is absorbed by molecules in the material, which respond by moving more energetically and producing thermal energy, or heat. If, instead, solar energy is intercepted by a semiconductor-material solar cell, for example, it excites electrons in the material and produces electricity by the photoelectric effect first explained by Einstein in 1906. These two conversion methods make different use of the same solar resource.

Collector efficiency is the ratio of energy gain (either thermal or electric) to incoming solar-energy flux. At the outer edge of the atmosphere, the solar flux is 429 Btu/h/sq. ft. for a surface facing the sun. On Earth, the corresponding clear-day solar-energy level rarely exceeds 350 Btu/h/sq. ft.

Solar assist for wind power?

Is it possible or practical to enhance a wind-power system with a photovoltaic system? What I have in mind is to use the solar unit to drive a motor and, by means

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of a clutch and belt, connect this to the propeller shaft of the windmill.

Vince Vasquez
Sacramento, Calif.

Your idea will work, but a better approach can be used. The DC power produced by your photovoltaic system can be passed through an inverter to produce AC power for your home. It is not necessary to run a motor to power a generator to produce AC. Your losses will be too high this way. A properly designed inverter will be substantially more efficient than a motor-generator setup. Use the generator for wind-power conversion only.

Heat-pump enhancer

I plan to alter one of two heat pumps to my house so that it can operate better at lower temperature. To do this I plan to raise the pressure of the outdoor air passing over the outside coils by about four psi and, after that, to recover most of the work left in this air by letting the air expand back to atmospheric pressure through a turbine. Do you see any problems with this scheme?

A. P. Sabol, Youngsville, N.C.

From the point of view of physics there is no problem; however, there are many practical problems. First, low-pressure-air turbines are expensive and inefficient. It is unlikely their cost could ever be repaid. Second, higher air pressure of itself does nothing to improve heat-pump performance. It is increased air flow *over the coils that helps most. Therefore, a low-pressure fan is enough.*

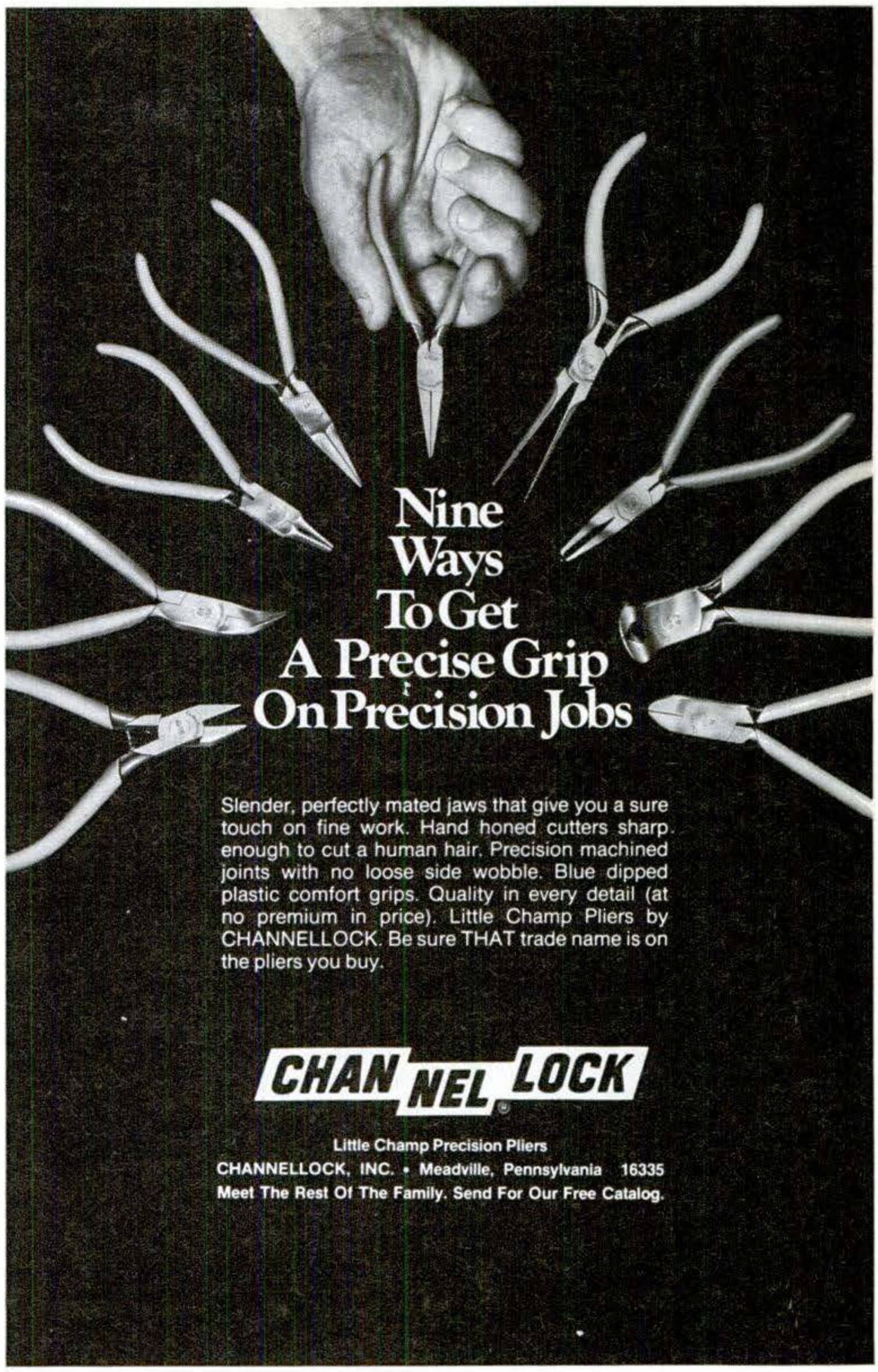
Win, place, and show

Which of the following three residential designs is the most energy efficient and economical: (1) log, (2) double-wall, or (3) standard construction with some earth sheltering? I plan to live in an area where there are some cold winter months. I will incorporate at least passive solar into the design.

Patrick Meyers
Grand Junction, Colo.

The most economical scheme with regard to both initial cost and lifetime energy saving is probably well-insulated stud construction with berming. Double-envelope buildings are too expensive for the amount of energy saved. It is better to build a well-insulated single-envelope house. Of course, logs can be insulated, but sealing these buildings against infiltration can be difficult. Logs, of themselves, have a low R-value.

Got a question on an alternate energy-such as solar, wind, water, or wood? Wondering about energy-conservation techniques for home heating or cooling? Every other month, alternating with "Adventures in Alternate Energy," Jan Kreider answers selected questions from readers. Send yours to "Energy Questions," POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. Individual queries can't be answered by mail.



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SHOP TALK

By AL LEES

Sweet sixteen for home shops

Of the many books sent to me for review within the past six months, these 16 titles (five hard-cover, 11 soft) offer the best instruction at the lowest cost.

Since this is our fall home-improvement issue, let's start with seven books on various aspects of energy saving, clustered to the left in our photo:

- *Solarizing Your Present Home* (Rodale, 671 pgs., $24.95) asks a big price for a big package—an encyclopedic work covering all facets of retrofit solar heating systems. In addition to illustrated instruction from many contributors, the book is a well-organized guide to other solar-project sources, as well.
- *Total Warmth* (Collier, 210 pgs., $8.95) is another group effort, accurately subtitled "The Complete Guide to Winter Well-Being," since it covers everything from weatherstripping to winter clothing. Best book I can think of to curl up with on a cold night.
- *The Energy Saver's Handbook for Town and City People* (Rodale, 322 pgs., $14.95) is still another group effort, compiled by the scientific staff of the Massachusetts Audubon Society. It's rare for a home-energy book to focus on urban conservation; this Boston team does it well and wittily.
- *The Home Insulation Bible* (Tab, 368 pgs., $13.95) is more tightly focused, with advice on how to select and install the most effective insulation for each use.
- Finally, three little handbooks on home energy: *Getting More Heat from Your Fireplace* (Garden Way, 156 pgs., $6.95) and *The Tighter House* (Rodale, 92 pgs., $5.95) concentrate effectively on their respective subjects, for less-obsessive readers. The latter is a concise review of major steps in upgrading efficiency.
- *How to Design an Independent Power System* (B.E.S.T., 128 pgs., $4.95) was reviewed for me by PS staffer Dan Ruby: "Going it alone electrically appeals to many people, but who'd have thought that a book about designing your own power system could make for easy, breezy reading? Without assuming reader knowledge of even basic electricity, author Terrance Paul (president of Best Energy Systems, makers of DC-to-AC inverters) offers nine rules of thumb that could start many of us down the road to energy independence."

Now, grouped to the right in the photo are books on more varied home-improvement and maintenance subjects:

- *Math for Construction, Workshop and the Home* (Popular Science Books, 664 pgs., $19.95) is a big, practical reference and instruction book on the ever-more-complex math problems we homeowners encounter. Much more than a text on shop math and metric conversion, this book tells how to figure electrical needs and construction details (beginning with a short course in the carpenter's square)—and there are chapters devoted to home-energy math and solar evaluations.
- *The Complete Handbook of Plumbing* (Tab, 400 pgs., $11.95) is a thick, well-illustrated paperback that answers just about any plumbing question a homeowner is likely to ask. It combines basic installation how-to with a thorough repair manual in a book to take to the job.
- *Working with Plastics* (Time-Life, 128 pgs., $9.95) is another in this series of home-improvement books noted for the clarity of the demo drawings. The book starts with a chart giving performance profiles of the major plastic families, then shows all basic techniques for cutting,

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trimming, forming and joining sheets, tubes, rods—and laminates. There's also a primer on molding resins.

- *The Complete Security Handbook for Home, Office, Car, Boat, RV, Anything* (Tab, 512 pgs., $13.95): With a title like that, any review would be superfluous, but this is an impressive compilation of data on hardware and systems for protecting yourself against theft and fire.
- Four new releases in a handsome series of large-format paperbacks for rack sale in home centers (Ortho Books, each 96 pgs., $5.95): *How to Design & Remodel Kitchens . . . Bathrooms* are parallel books, organized to precisely the same formula, starting with a proposed survey of your existing facilities then reviewing the restyling possibilities. Photos are all in glamorous color, showing kitchens-baths devoid of people—the only way they'd stay looking so neat. But both books turn practical when they get into floor-plan development, shopping for appliances and fixtures, planning color schemes and lighting details; and there are practical tips on ripping out the old and installing the new. *Basic Plumbing Techniques, Basic Wiring Techniques*—again, twins, but very different from their twin sisters above. Here the emphasis is strictly on tools and techniques, with only a handful of color photos for decoration. The color diagrams are fresh and informative. As basic manuals to teach you how to deal with your home's vital systems, these books would be hard to beat.
- *Automechanics* (Reston, 671 pgs., $19.95) is the bargain of our group. It must be that the publisher wanted to keep the price low to attract orders from vocational schools, for this is really a textbook, with questions at the end of each of its 46 chapters.

The author is PS Consulting Editor Richard Day, who in 1980 completed a series of pieces for us under the banner "Day on Car Care," and who is back with our auto-maintenance feature in this issue.

The book is designed for the novice mechanic, taking him through to the advanced stages of DIY. It's up-to-date, with closed-loop emission-control systems, small-car emphasis, and coverage of diesel engines. There's a chapter on how to obtain and use the shop manual for your car. All major systems get thorough treatment: ignition, fuel, starting, cooling, charging, and electrical. The 16-page index is the best I've seen. Reproduction of a few photos is disappointing, and a handful are dated, but most of them (they're all black-and-white), and all of the diagrams, offer clear instruction. PS

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Plastic engine

[Continued from page 72]

official decibel-level testing has been done, Holtzberg claims that muffled composite engines run much quieter than either aluminum or steel engines.

The second major advantage, Holtzberg claims, is gained when composites are used in the valve train. Holtzberg and Ford experts feel that if the weights of reciprocating parts can be reduced substantially, engine speeds can be increased, engine durability maintained, and fuel economy, perhaps, increased.

Holtzberg referred to a test that reported an 1,100-rpm increase in engine speed before valve float (harmonic imbalance) when a 44-gram (1.6 oz.) Polimotor valve was used instead of the standard 144-gram (5.1 oz.) valve. SVO's engine engineer, Rodney Girolami, says that just using the composite push rods provided a 1,000-rpm float-speed gain in some Ford V8's. Such improvements are unheard of in the auto industry.

Why does a giant such as Ford rely on Polimotor, a small company with a total of nine employees, to pioneer this development? Holtzberg attributes it to the terribly high cost of developing an engine within a corporate structure.

Holtzberg has applied for more than 30 patents on the processes for making the components and engine. But he says he's not really afraid that somebody will steal his engine: "If it takes five to seven years to build a new iron engine, no one will build a plastic engine tomorrow." However, Holtzberg wouldn't discuss the specifics of his composite material.

Recent technological advances have provided the composite industry with polyimide resins that are stronger and more heat resistant. Most of these polyimides resist automotive solvents and fuels, as well as battery acid and water. But a major problem still to be solved results from the low temperature limits for most resin-matrix materials. Many of the early resins would not survive above 400 degrees F, and even the newest will withstand no more than 700 degrees F and cannot be held at that limit for long.

Holtzberg showed me one of his first pistons, which he keeps on his desk. There was a hole through the crown that you could put your finger through. Smiling, he picked up the black composite piece: "We quickly learned that a 600-degree-F resin piston would need an insulator on the top." Polimotor's pistons now incorporate an aluminum crown to withstand the combustion temperatures and to carry the piston rings. The plastic valves are also made in two parts. The face and neck are metal to handle normal valve temperatures, which reach 1,400 degrees F, and the stem is carbon fiber. Holtzberg is also experimenting with a temperature-resistant ceramic coating for valve parts subject to combustion temperatures.

Are his FRP components as rigid and strong as conventional metal components? "They're stronger," Holtzberg says. "We have greater control over the placement of our fibers to make them stiff, as opposed to just increasing the cross section with isotropic materials [metals]. In fact, our engine block is at least twice as stiff as any of the aluminum blocks we compared it with. These engines will last. The oldest engine we have has about 600 to 700 dynamometer hours on it. Typically, a Detroit engine only has to last 100 to 300 hours."

Fiber orientation is one of the key considerations for composite applications. That refers to the position of fibers within the matrix relative to the direction of load stresses imposed on

Continued

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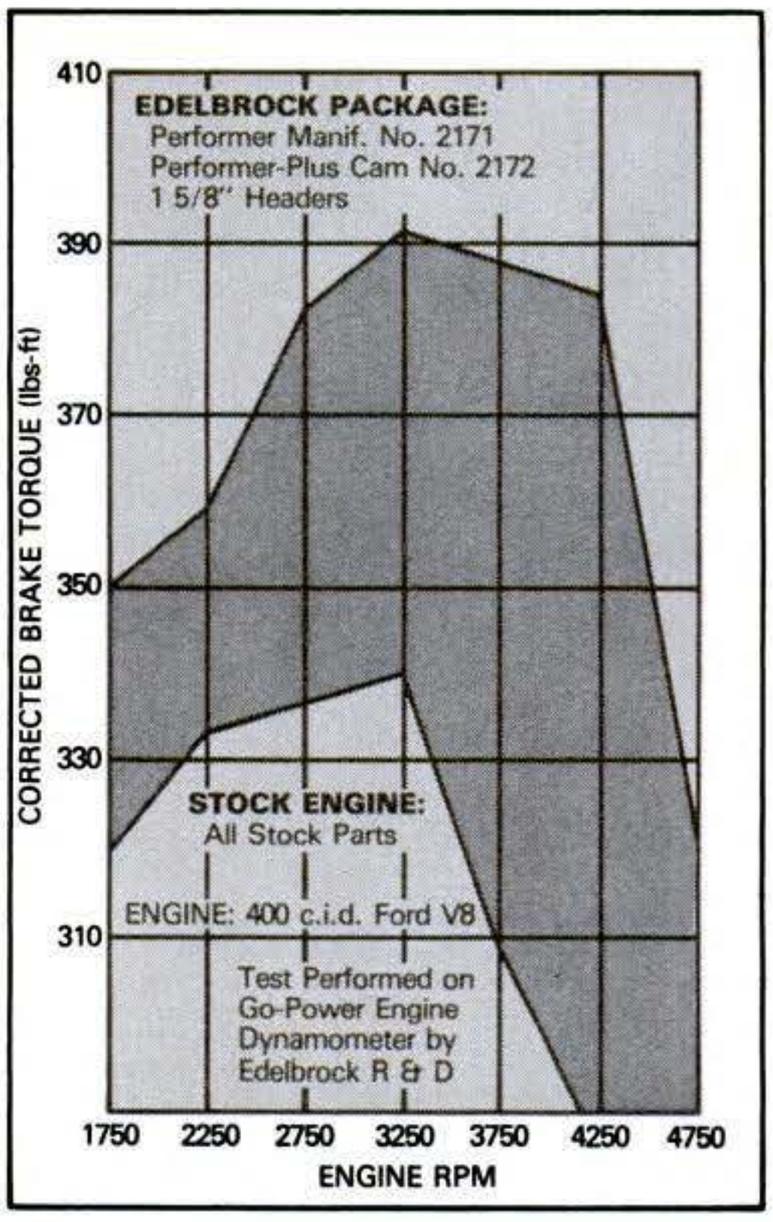

***THE PACKAGE:** U.S. Automotive's, Lyn McQuilliams, installed a Performer 400 manifold, Performer-Plus camshaft, 4-bbl carburetor and dual exhaust on a customer's 400 c.i.d. Ford Bronco. The 3-second acceleration gain was from a dead stop to 100 yards! Says Lyn, "My customer was elated!"

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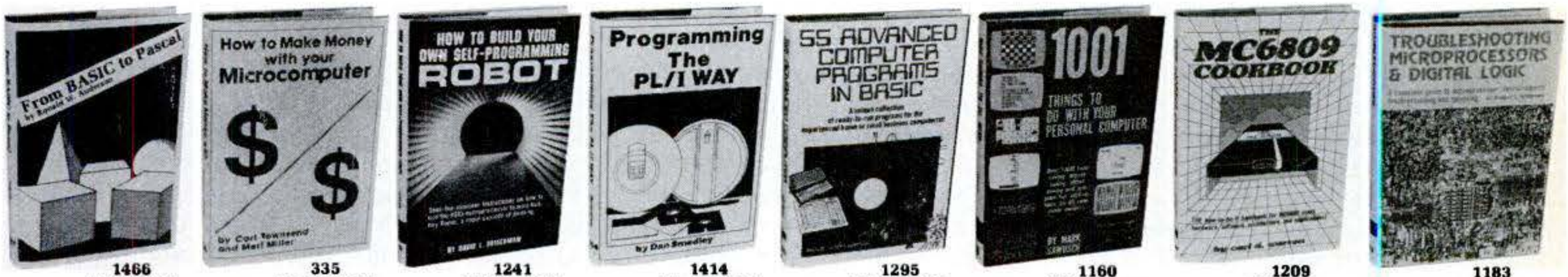

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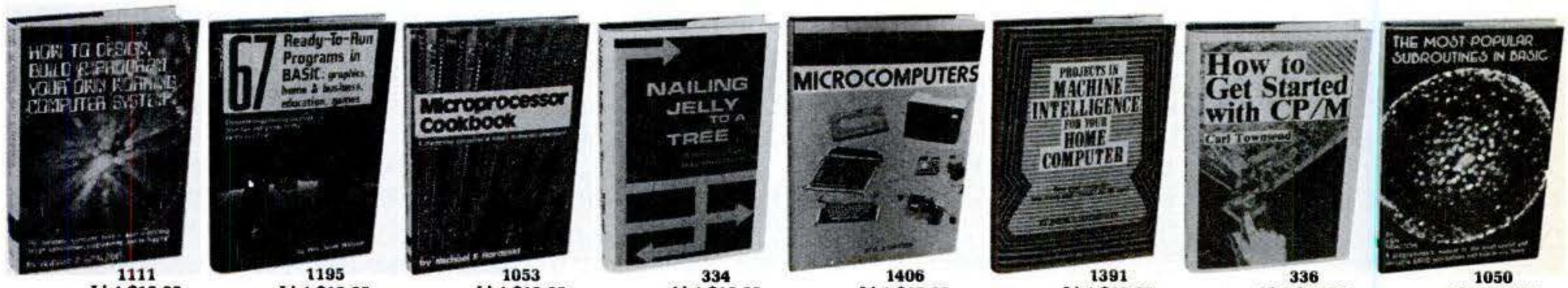

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Plastic engine

[*Continued*]

the component. Orientation and hybridization, in which different fiber types are combined to obtain specific properties, are used in much the same way as alloys are used by metallurgists.

Holtzberg has also been experimenting with composite hybrids. Most of these are laminates of glass and carbon fibers. He is able to combine the relatively low cost and impact strength of glass with carbon fiber's much greater flexural and tensile strength. However, according to Holtzberg, "You can sometimes use twice as much glass as carbon fiber—sometimes even more than that—to get the same properties. And then, of course, the part is no longer as light as it should be."

When will we see composite materials in our automobiles? Holtzberg and Ford agree that it may be some time before volume-production techniques are perfected. "You can do a lot of things on a small scale, but when you start talking about converting an engine line, that's a big decision," remarks SVO's Lyall.

The cost of building engine parts, especially the smaller valve-train components, is high. For a single machine, initial tooling using an injection-molding process would run anywhere from $725,000 to $1.1 million, according to a recent estimate in *Automotive Engineering*. At a time when costs are being pared in Detroit, this is a steep price to pay for change.

There's also the price of raw materials. Carbon fiber, which makes up the better part of the engine components, sells for $20 to $40 a pound; aluminum sells for somewhere around $2. Of course, the price of carbon fiber might drop as more applications arise. Some experts say that the price may go as low as $5 a pound within three to four years.

Another big stumbling block: Although the material can be threaded, bolts screwed directly into the material pull out much too easily. Holtzberg uses some adhesives, but he told PS that he has become wary of manufacturers' performance claims. Most of the new industrial adhesives produce impressive performance values, but, as with resin, they have low thermal tolerance. Even the most heat-resistant adhesives start to break down at temperatures barely exceeding 192 degrees F.

Fortunately, Holtzberg was able to use a part, called a Helicoil, that is normally used for thread repairs. The metal Helicoil is threaded into the material first, and then the bolt is threaded into the Helicoil. Pullout resistance is increased tremendously. These fastening methods suffice for affixing light components, such as the fuel and oil pumps, to the engine block, but the strains imposed by the thrust of rotating parts and by combustion pressures demand an even surer method.

Holtzberg realized that although composites showed poor performance when tapped, they possessed a very high flexural modulus (resistance to bending). His answer was to install long studs through a plate of composite in the head and a second plate sandwiched between the block and the structurally loaded oil pan. Nuts are installed on both ends of the stud; the engine is held together by compression from each end of the stud.

Areas for composite applications are becoming increasingly apparent to auto makers. If FRP engines and performance parts prove themselves in Mustangs on European race circuits this summer and next year, composite engine materials will surely be one of Ford's "better ideas," and we'll be hearing much more about them. PS

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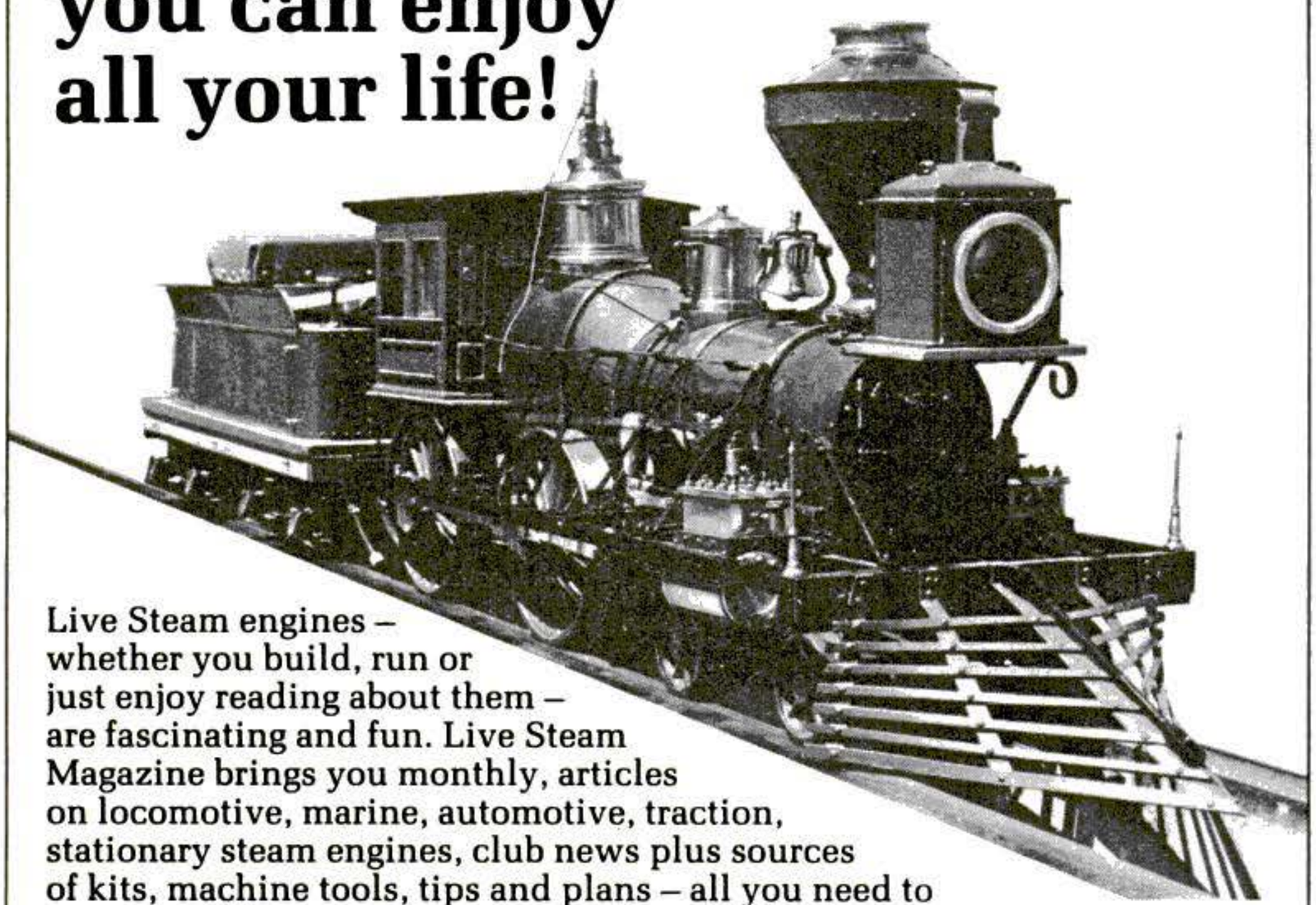

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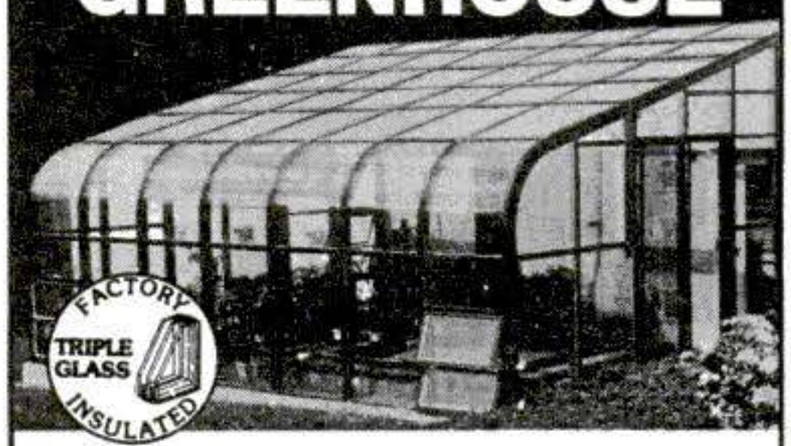

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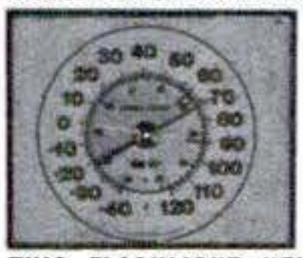

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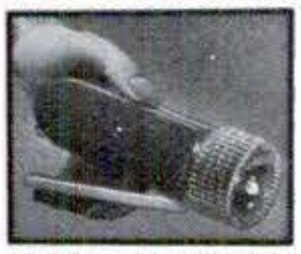

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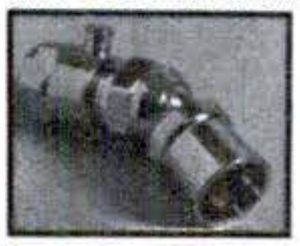

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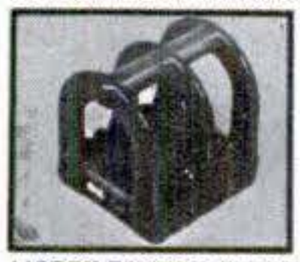

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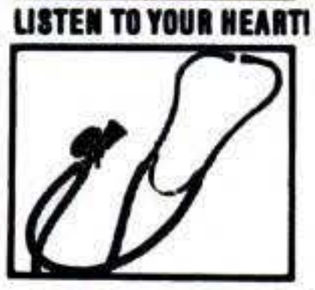

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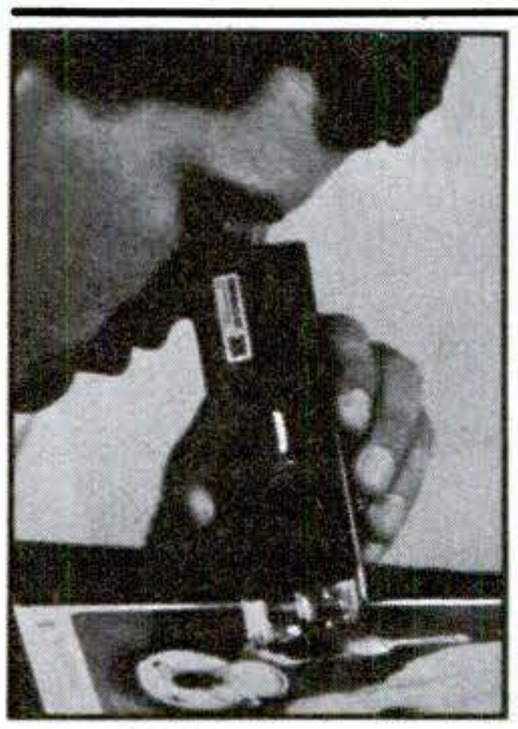

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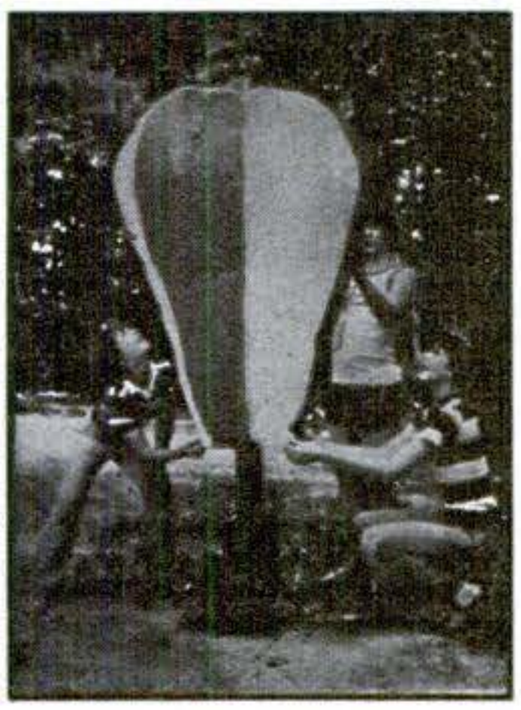

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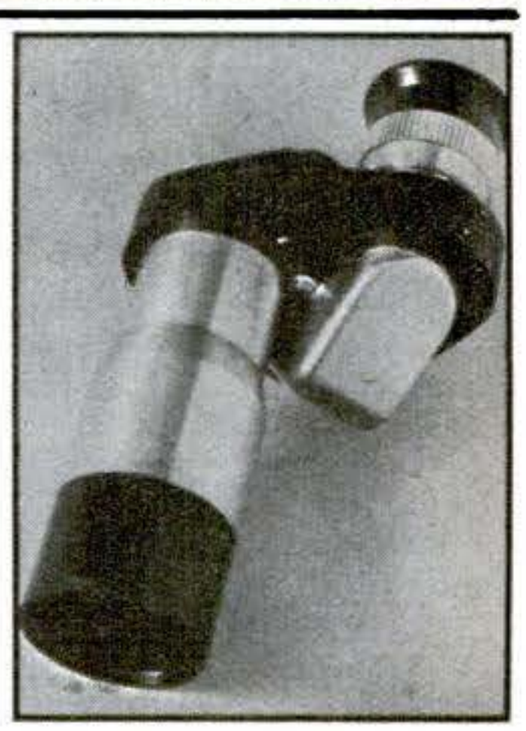

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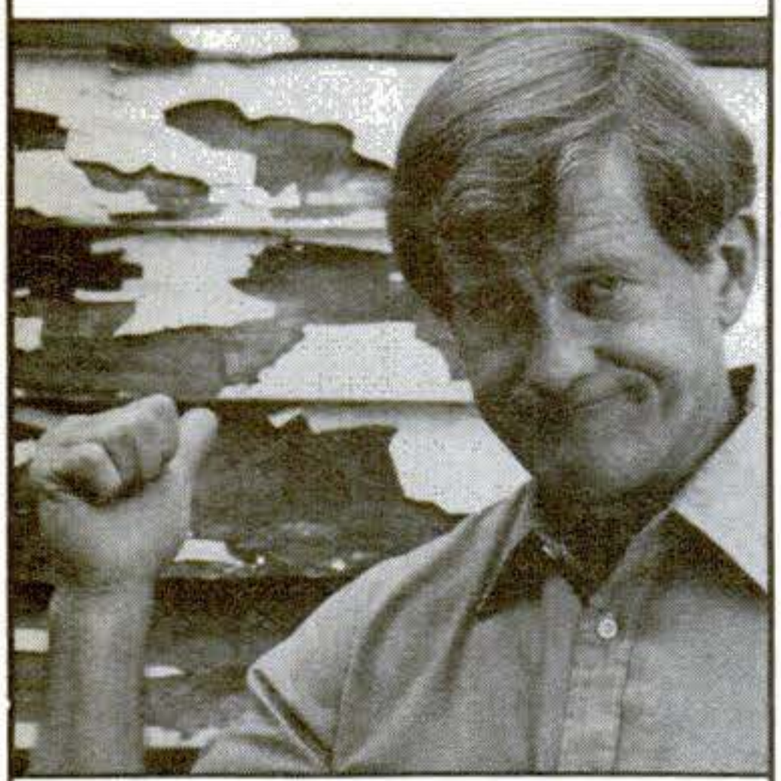

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Shifty Chevy

Are modern-day gasoline engines so hobbled by government edicts that we can no longer expect smooth delivery or power? My 1981 Caprice acts as though it's starved and shifts abruptly through all gears, including overdrive. It's gone only 3,000 miles, but the service manager says he can't help me.

Walter Tanberg, McAllen, Tex.

Emission controls are causing most of your problem: Too much EGR and advanced ignition timing make the engine feel as if it's running lean, and this causes the transmission to be rough. But you shouldn't experience rough shifting, just some jerkiness in high. Your problem's not normal. Fixes? Check the EGR valve and spark control very carefully.

Adiabatic engines?

When will we start seeing high-temperature, uncooled, adiabatic engines made from silicon nitride and running with dry lubrication? Is lubrication, wet or dry, the only remaining problem?

Larry Forbes, Los Angeles, Calif.

Adiabatic ceramic engines are a long way off—10 years, maybe; but partial-ceramic engines are running now [PS, March]. To my knowledge, none is totally uncooled. Cummins diesels [Cummins Engine Co., Inc., 1000 Fifth St., Columbus, Ind.] are running engines headed for the elimination of cooling, and synthetic lubes will be able to handle the job when the time comes. The main thing is that adiabatic engines are launched—but we're in for a long, bumpy ride.

Propane—ifs, ands, buts

I expect a huge increase in gas prices in Canada in a few years and am thinking of converting to propane. Can you give me some information sources and tell me about the pros and cons? What about pollution gear, winter starting, etc.?

Harold Lichtman, Winnipeg, Manitoba

Propane is a good fuel, but the name is often used to mean LP gas, which is a mixture of propane and butane. Propane vaporizes much better than butane in cold weather, so you'd need more propane in your mix. Impco Carburetor [Los Angeles, Calif.] has good equipment and expertise. Autotronic Controls Corp. [El Paso, Tex.] makes the best ignition equipment for the fuel. LP likes more compression and more spark advance, and it's hard to start in cold weather. It's a clean fuel, and engines that use it last longer; but it will soon be in short supply and cost more than gasoline. LP fuel and 1982–'83 emissions equipment are cats and dogs, but the mess can be worked out by an electrical genius. If it keeps up, by 1986 all mechanics will either quit or go insane trying to figure out what happened.

Rear axle spewing lube

I have a 1977 Ford LTD station wagon V8 automatic. At 62,000 miles the vent on the rear axle was spewing out oil. I checked oil level for the next 2,000 to 3,000 miles, and it was ¾ in. below the fill hole. Shortly afterward, the left axle seal leaked into the brakes. The axle was removed and all new seals were put in. The car now has 71,000 miles, and oil again comes out the vent as if under pressure. The local and Ford mechanics have no answer except to watch oil level and replace the seal. At $100 a shot, that will get out of hand.

George Chellberg, Leland, Ill.

A bad bearing can heat oil, causing it to boil and overcome the seal. Check the axle bearings on the left (worse) side and look for heat and roughness.

Batteries different?

I've been told that the only difference between 36- and 60-month-warranty batteries (same make, type, and ampere-hour rating) is the price. In other words, with a 60-month battery you're paying for the warranty. What do you say?

Kenneth E. Adams, El Paso, Tex.

I don't agree. Weigh a 36- and 60-month battery and see if they're the same. But which will last longer may be a different story. I haven't seen many batteries make two years lately, let alone five.

Turbo for MGB?

I have a 1967 MGB-GT, and it's going to need an overhaul soon. I'm thinking of installing a turbocharger. I'd like to know if you think a five-main-bearing engine running at 8.8:1 could stand five lbs. of boost, or would I have to drop the compression ratio? Also, should I install a turbo cam from Ed Iskenderian Racing Cams?

Matthew Silveira, Tulare, Calif.

It should be able to stand the boost. I agree on the Isky cam retrofit.

Burned ignition parts

Help! I've seen rotor caps burned through, even one burned through to the coil on a GM high-energy-ignition engine.

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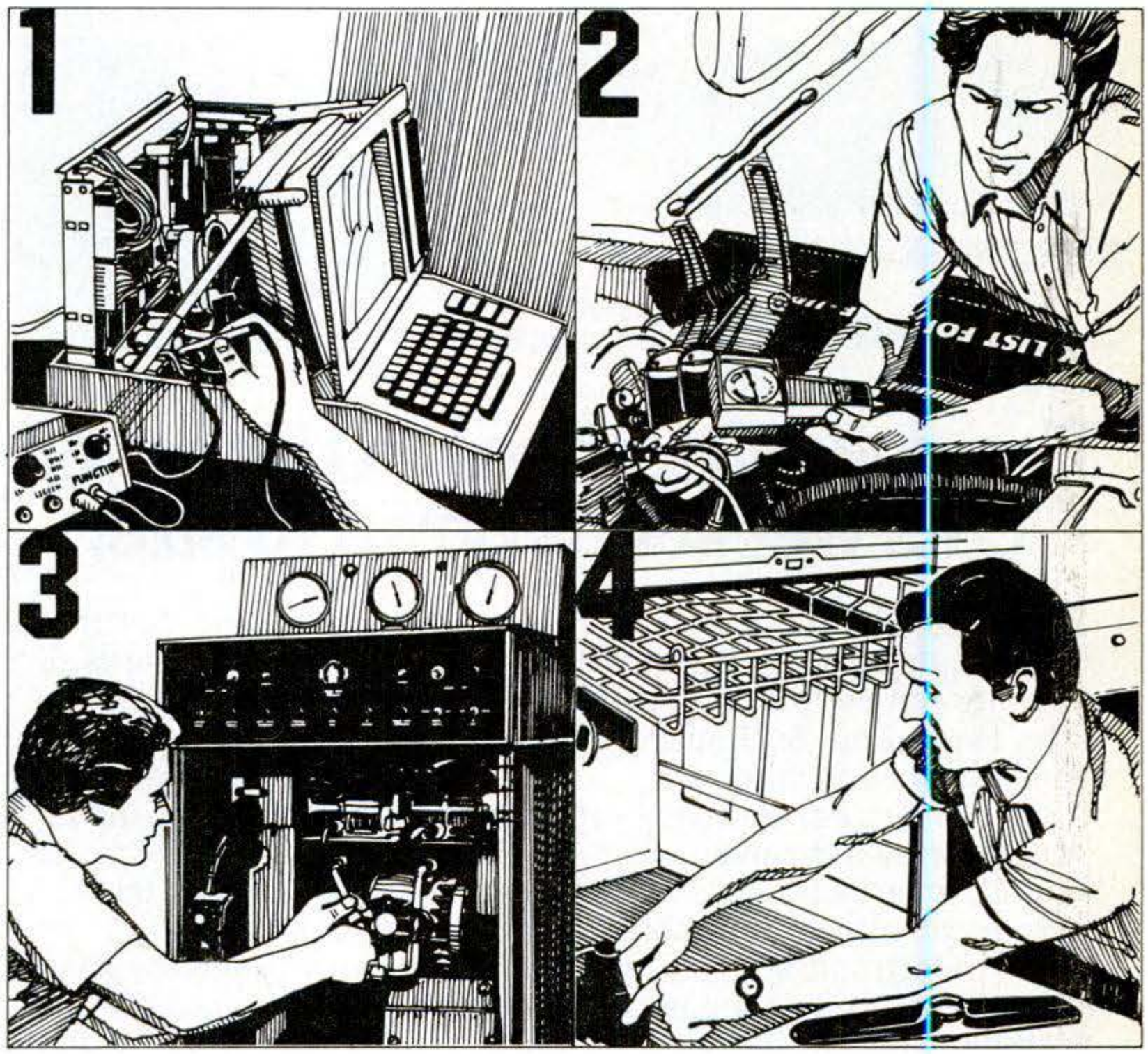

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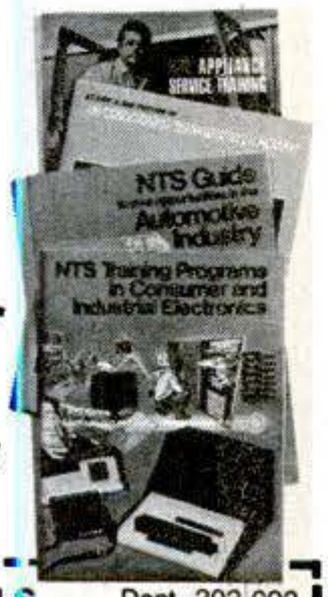

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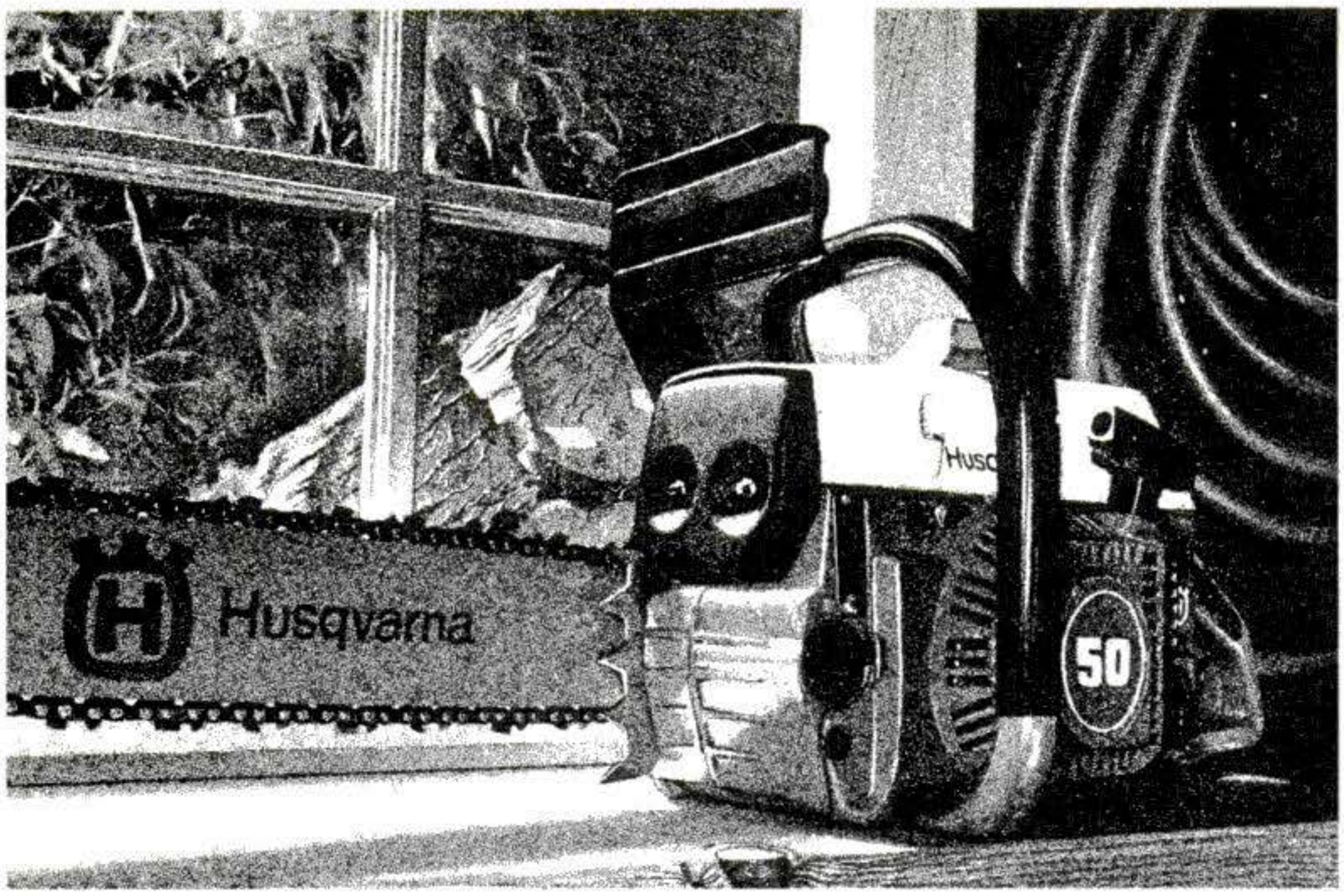

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"Say, Smokey—"

[*Continued*]

I've also heard of people having their GM cars quit when the expensive electronic unit in the distributor goes out. I own a 1979 403-cid Buick and don't want these things happening to me.

Rex R. Bahr, Topeka, Kan.

Nylon screws to hold the rotor will help. Be sure you have tight connections at the battery and alternator. A good distributor-cap vent with no moisture or oil film in the cap will help, too.

Cold truck's cranky

My 1979 Chevy 4WD truck with six-cylinder engine starts okay, but gets cranky after several blocks and then runs fine when warmed up.

Barry Smith, Payson, Ariz.

You need to stay in the cold mode until water, air, and intake manifold get up to the right temperatures. Check whether the thermostat opens too quickly or whether the exhaust damper, carburetor hot-air motor, or choke itself comes off too soon. You don't want any EGR before warm-up. Set everything to Chevy specs and I think it'll cold-drive okay.

Weird mpg numbers

I have a 1980 Toronado diesel. I get 23–24 mpg around town; however, driving on the highway at speeds of between 55 and 65 mph I only get 22 mpg. The dealer service manager shrugged his shoulders saying he never heard of such a thing.

Won H. Bae, D.D.S., Marlboro, Mass.

I believe your problem can be solved by a good diesel shop that is a dealer for your injector system. Recalibration and adjustment has helped many we have done. It takes about $50,000 in equipment to do it right, so you won't see much of this around at car dealers.

Air cleaner acted as choke

Right after replacing the air-filter element in my 1980 Cutlass it became necessary to cold-start the engine twice because it seemed to lean out and die three or four seconds after the first start.

J. B. Burdeaux, Lansing, Mich.

The original cleaner may have been clogged by dirt, causing the engine to run a little too rich. Study the cold-choke setting and the EGR system very closely. Check exhaust-heat dampers, carburetor hot-air vacuum motor, and water-temperature sensor that controls EGR—it could be cutting in way too early.

Each month, Smokey Yunick answers questions on cars—family cars, high-performance models, and racing vehicles. Got a problem? Send it to: "Say, Smokey—", POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. All letters are read, and those of widest interest are answered in this column. Due to the large volume of mail, Smokey cannot reply to letters that are not selected for publication.

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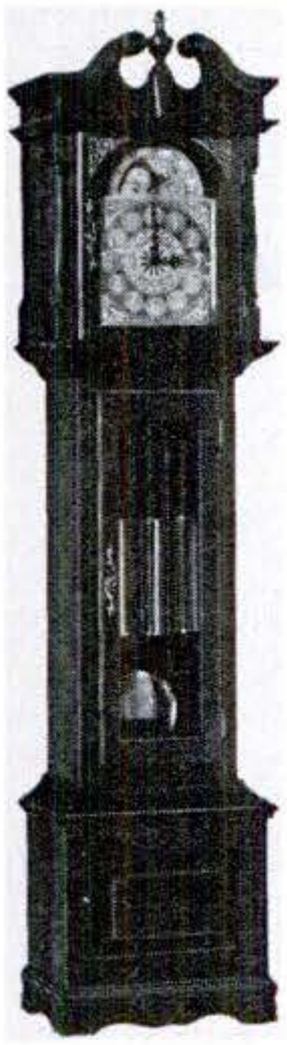

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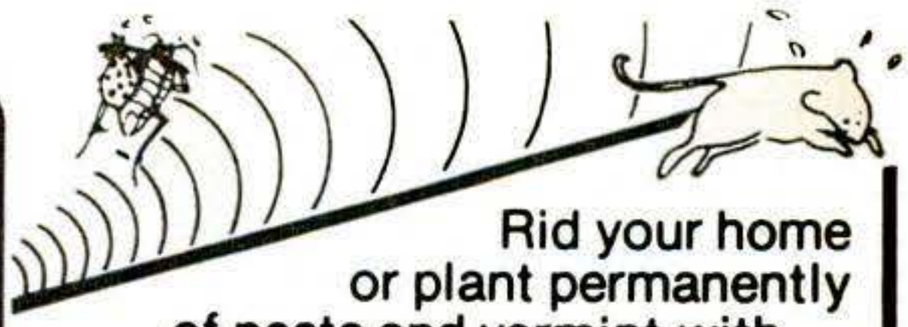

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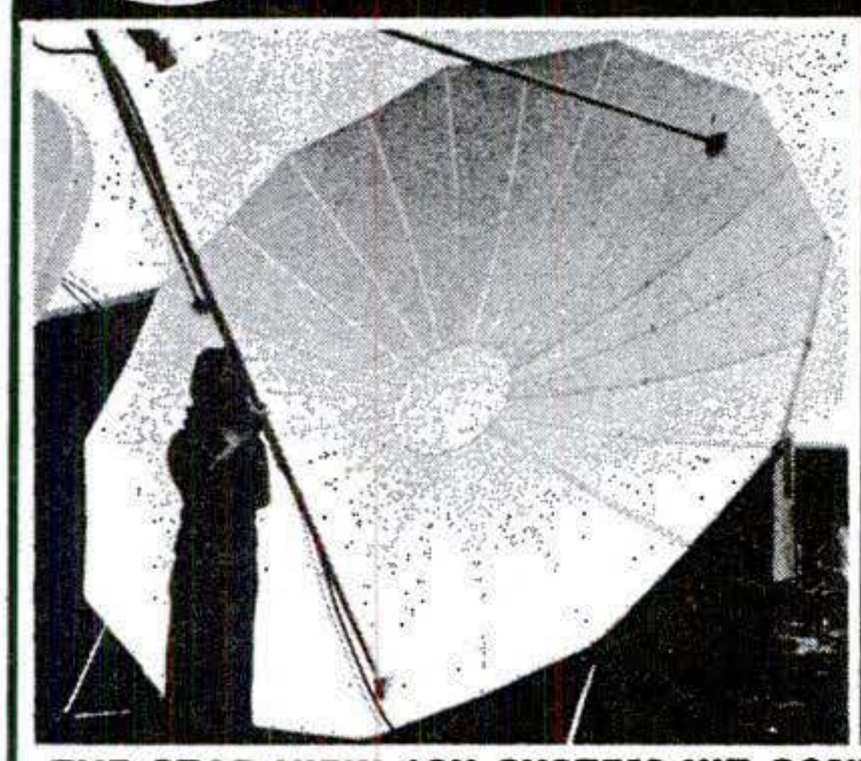

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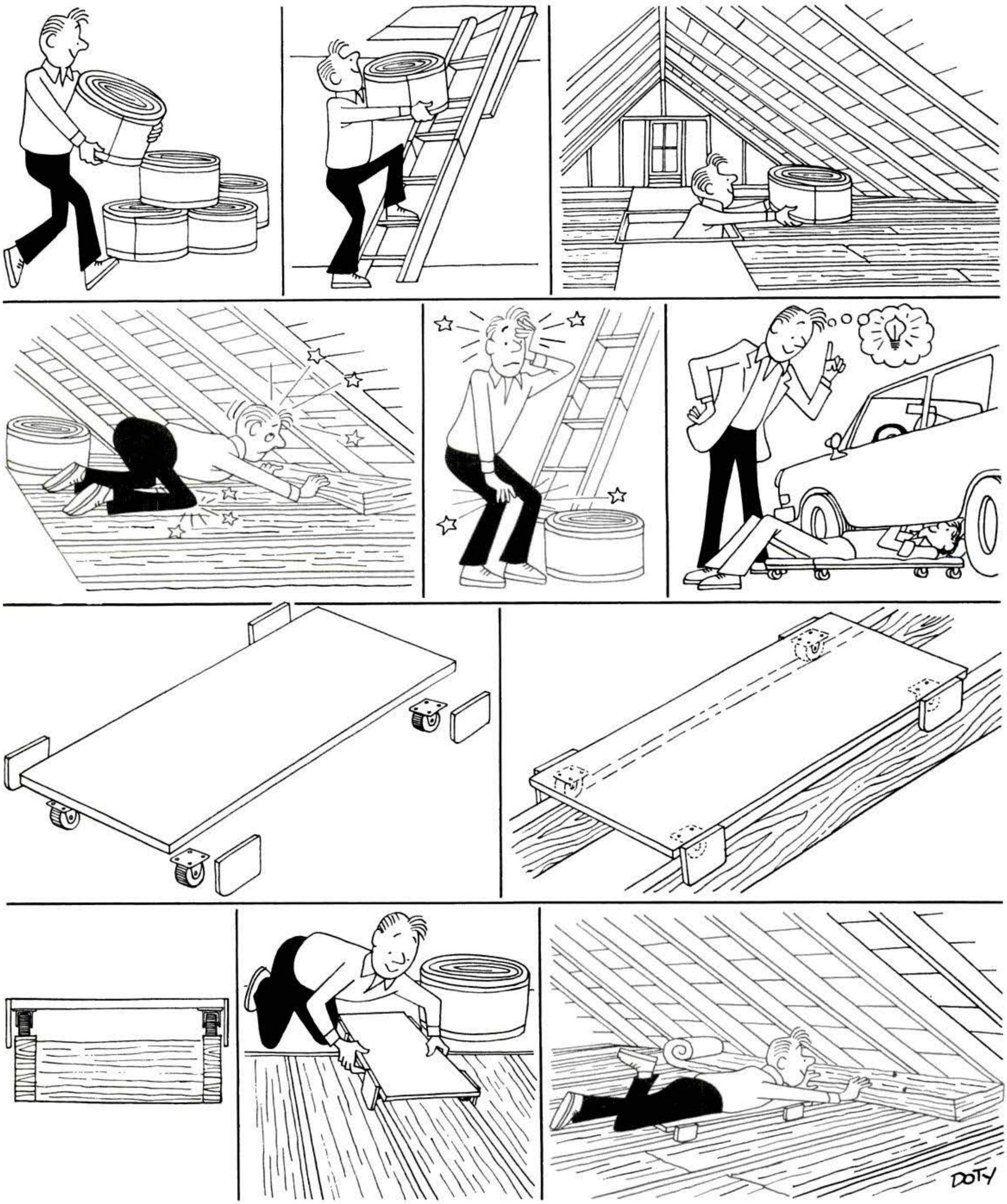

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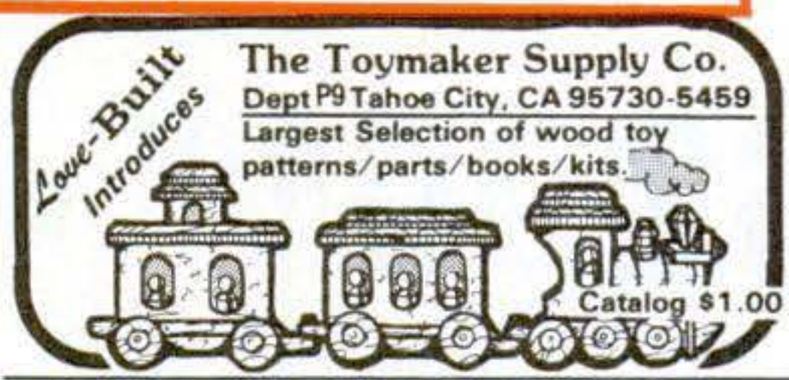

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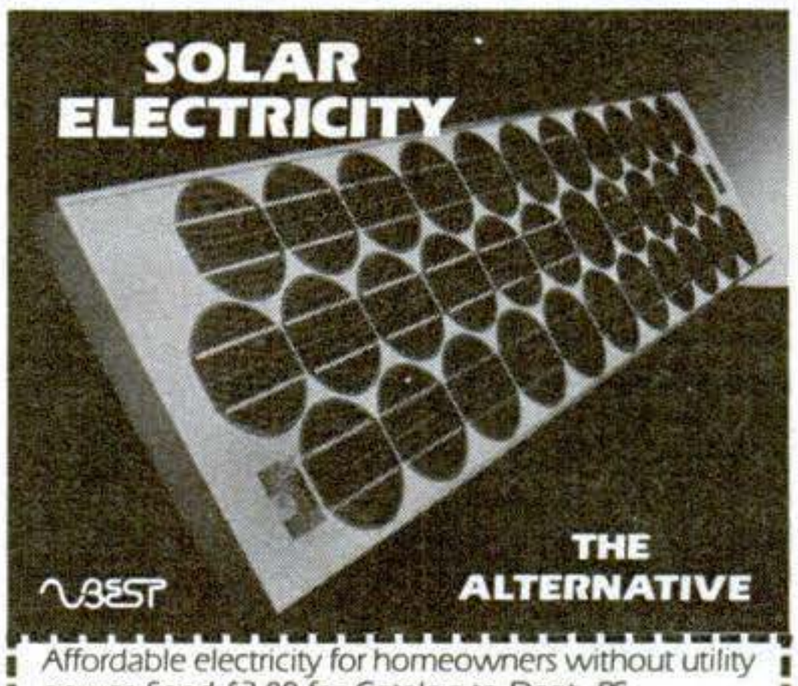

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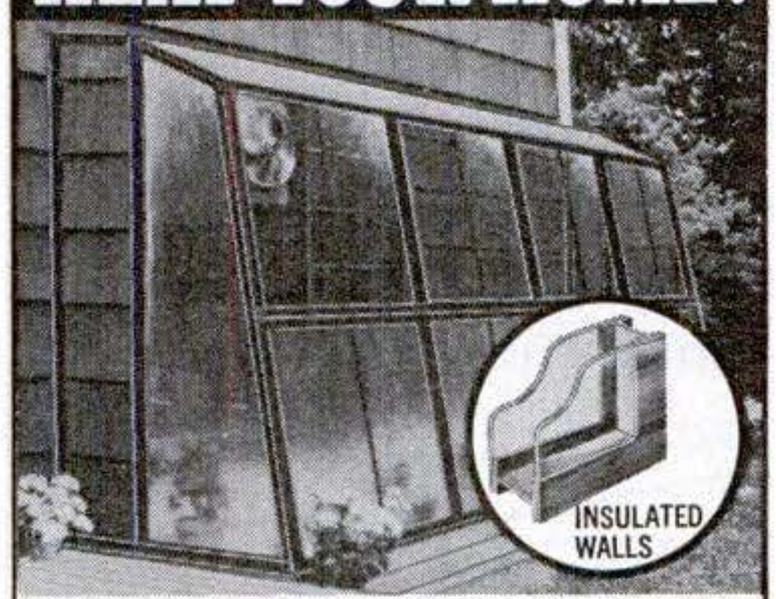

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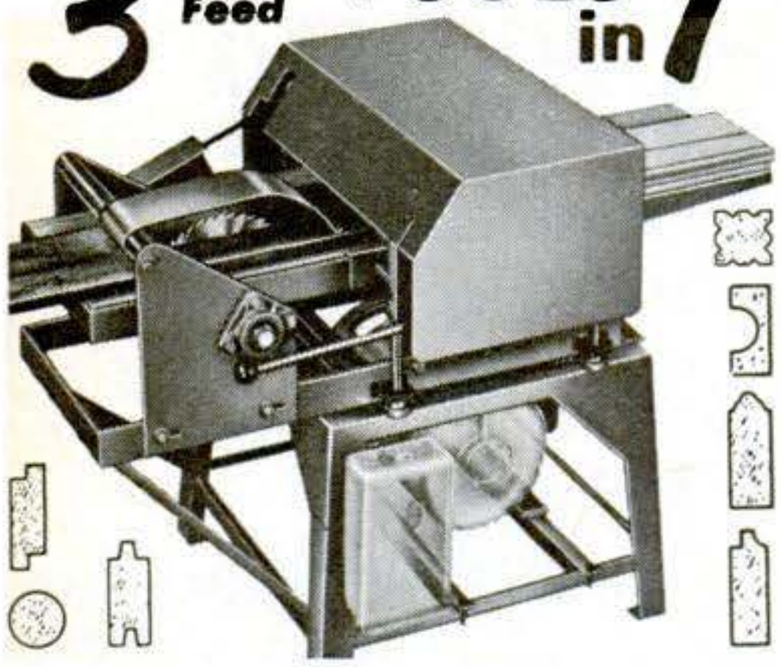

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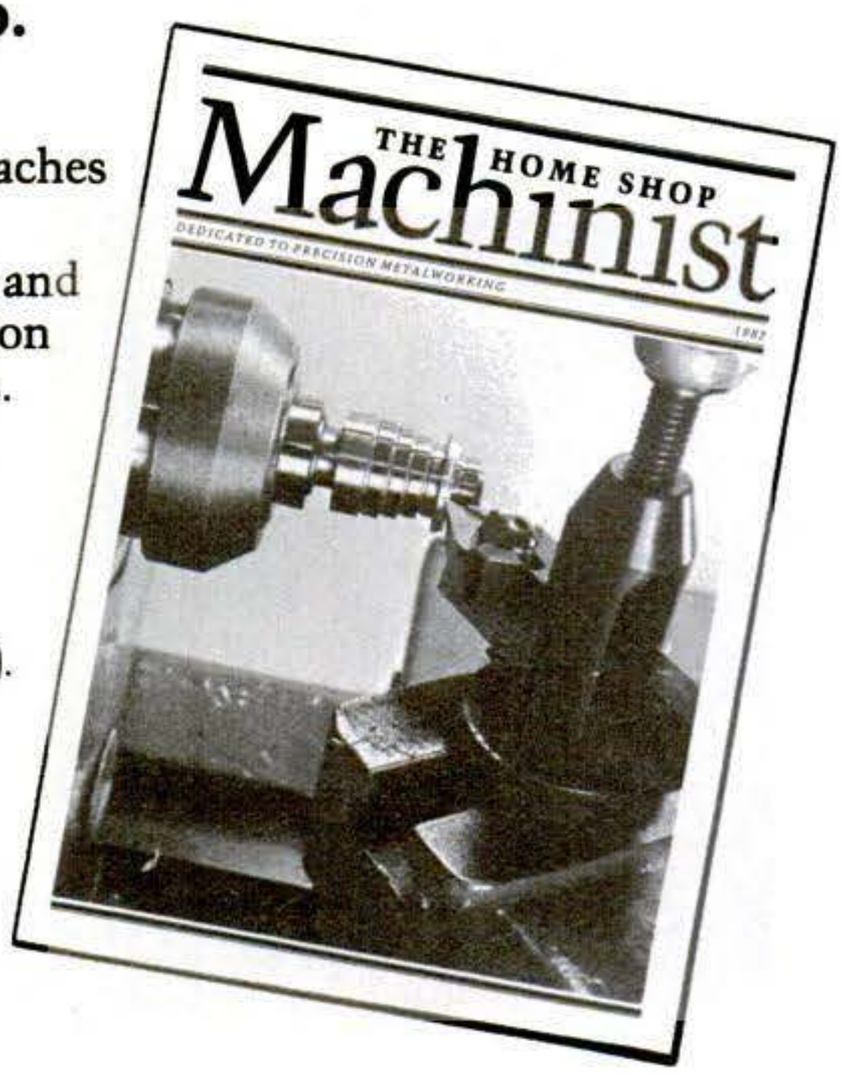

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HOW TO DRILL A BACKYARD WATER WELL

BILL HARRINGTON

I've been drilling water wells in Oklahoma for about 15 years.

When I first saw the ad that claims a man can drill his own water well with a Hydra-Drill, I was extremely skeptical. I thought to myself — how can that be? That's impossible. It takes a big engine, it takes a big rig to drill a water well. But my curiosity kept nagging me, so I sent off for the information.

My daughter's boyfriend is a well driller over in Arizona. I showed him the Hydra-Drill literature. His first reaction was "I don't believe it. I don't believe a 3 hp. drill can do the same thing my 100 hp. drill does." But the more I studied it, the more it sounded like a good idea.

A WATER SHORTAGE

Another thing on my mind was the drought. We're having the worst drought here since the dustbowl days back in the '30s. A lot of towns around here all the way over to Tulsa are running short of water, and some of them have started water rationing. It's very hard on a lot of people, but business is good for well drillers. I'd been thinking about buying another drill and putting my son Robert in business. He's 18 years old, and he'd never worked on a drill before. I decided he could learn with a Hydra-Drill.

EASY SET UP

Now when I started out in the drilling business 15 years ago, I had a big drill that just about worked me to death. Later, I got a rotary drill. It was easier to operate, but it took a day and a half to set up and drill a well in this area. You can't imagine how I felt when they delivered our Hydra-Drill. It was so compact, very simple. Robert and a young friend of his took it out and set it up in just a few minutes.

OUR FIRST HYDRA-DRILL WELL

The day we went out to drill our first well with the Hydra-Drill, I was all fixed to work with the boys and give them plenty of advice. However, it was a very hot day — about 100 degrees — and once they got started drilling I could see they didn't need me standing right there, so I went over and sat down in the shade of a tree. In about an hour, they came over and I asked them if they were taking a break, and they said no, they had just finished drilling the well.

It was amazing. They had drilled down forty-seven and a half feet and hit a layer of beautiful, coarse sand — the kind that produces good water and a lot of it. They had drilled that well in less time than it takes me just to set up my big drill.

PHOTO BY TONY JACOBY

Later, I figured they had drilled that well with less than one gallon of gas. My big drill would burn up at least fifteen gallons of gas for that job!

MAKES MONEY

The next day we drilled a well 115 feet deep through rock, and it went fast too. The Hydra-Drill really takes the hard work out of it. It's fast and economical, and that's what it takes to make money drilling wells.

Also the Hydra-Drill is so portable we can set up and drill anywhere. In the past, I've lost out on some jobs because people were afraid my big drill would tear up their yard. With the Hydra-Drill, we can drill without tearing up anything or making a mess. This is a big selling point to my customers.

I'm just grateful to have this Hydra-Drill. I've got my son started in a good business he can make some money with. If I had bought another big drill, it would cost thousands of dollars, and that is just ridiculous because the Hydra-Drill does the job just as good. In fact, I figure we earned enough to pay for the Hydra-Drill the first week. From here on, we're in the blue chips.

GOOD, PURE WATER

I believe anyone can drill a well with a Hydra-Drill. Even if they just wanted to drill their own well, they'd save money. It's simple and it's easy if they just read the instructions. And the best part about it is that you get good, pure water without all those chemicals in it, and the water costs you, say 5 cents for a thousand gallons. You certainly can't buy city water for that. And it's a great feeling to have all the water you want even when the city is rationing water to everyone else.

The man who invented the Hydra-Drill really knew what he was doing. Modern technology is a wonderful thing, isn't it?

NOTE: Popular Science readers can get a big, fully illustrated information kit on the Hydra-Drill including a booklet, "How to Drill Your Own Water Well." The information kit is available free, without obligation. Requests should be addressed to DeepRock Mfg. Co., 195 Anderson Road, Opelika, AL 36802.

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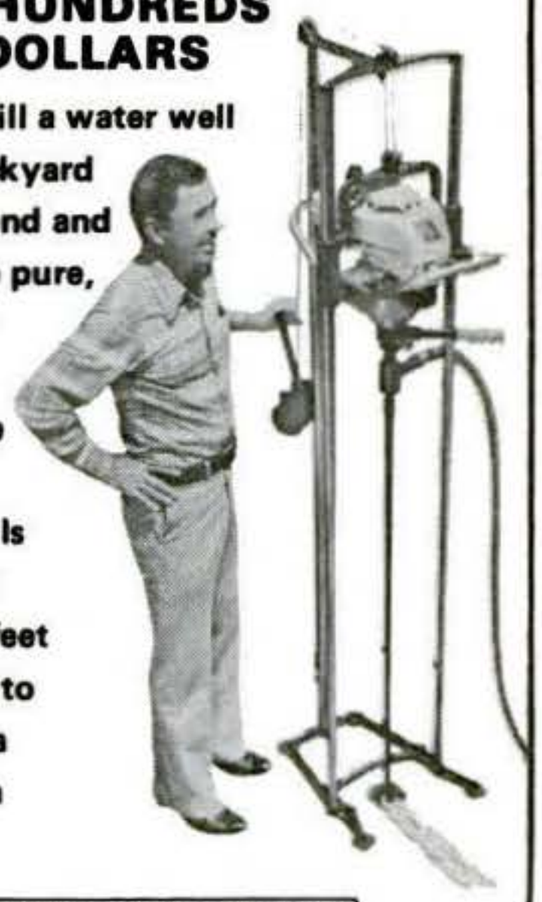

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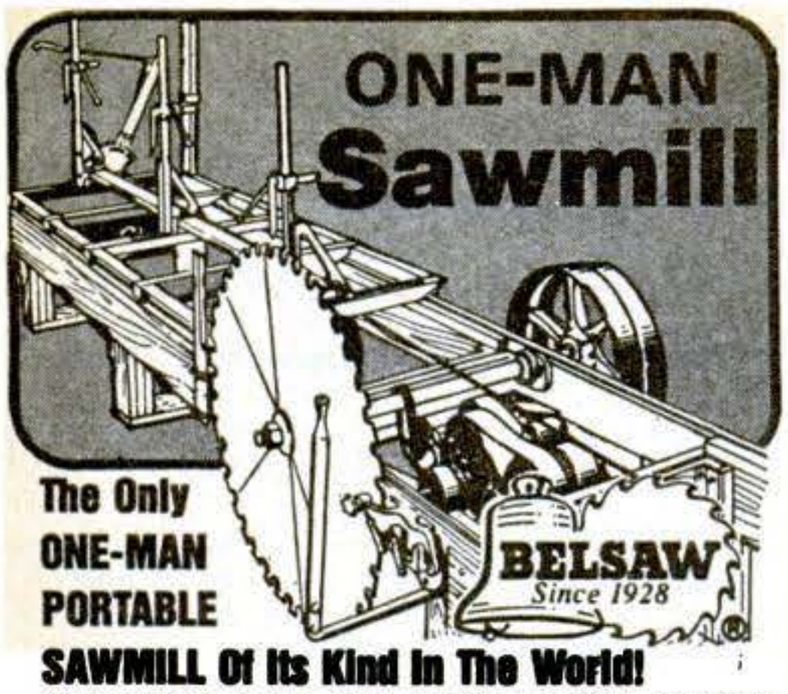

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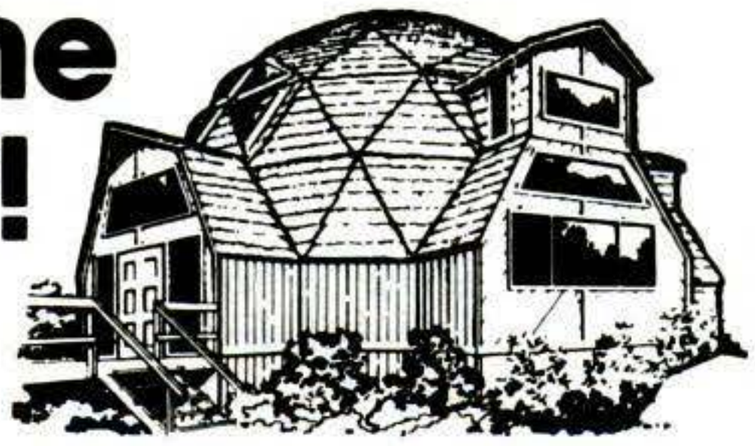

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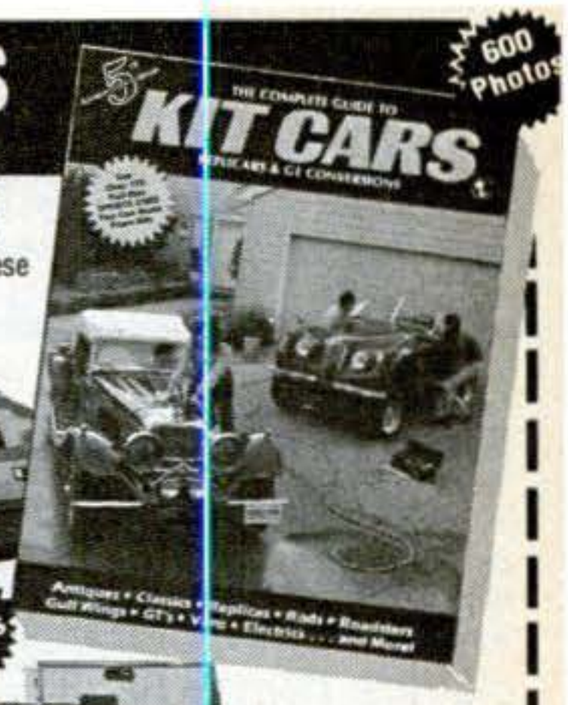

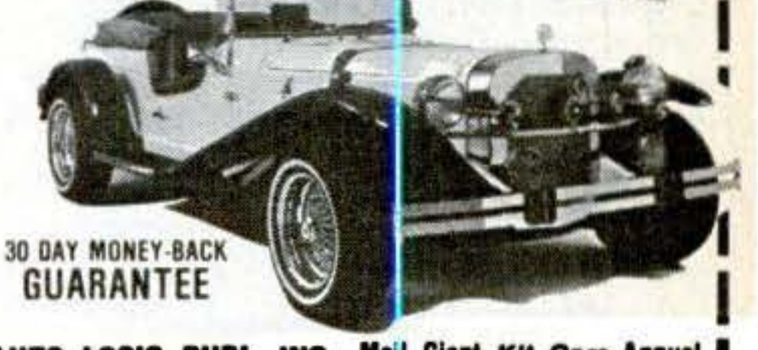

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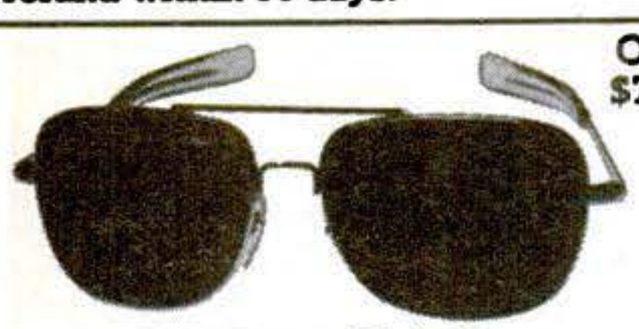

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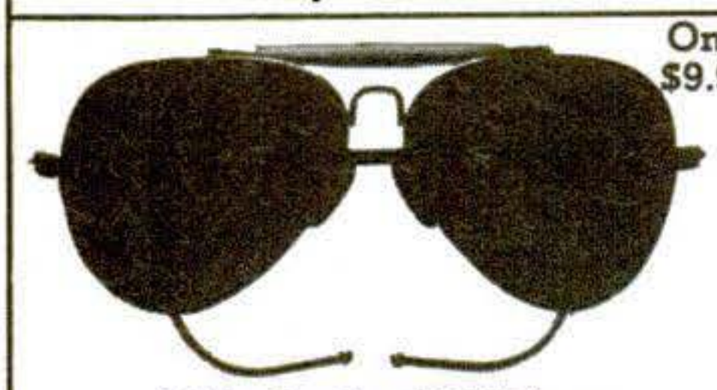

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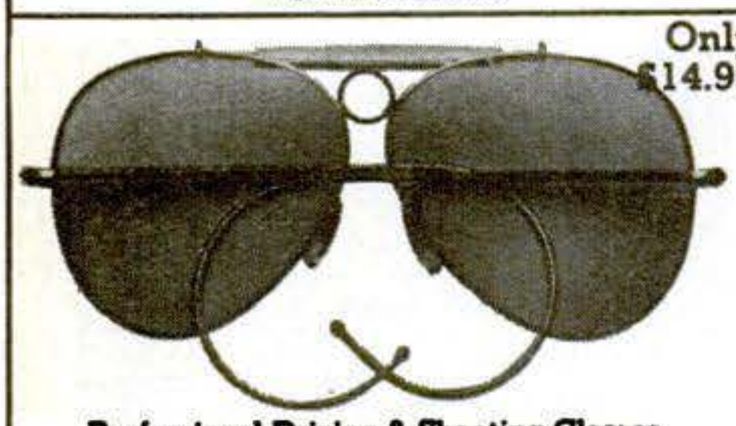

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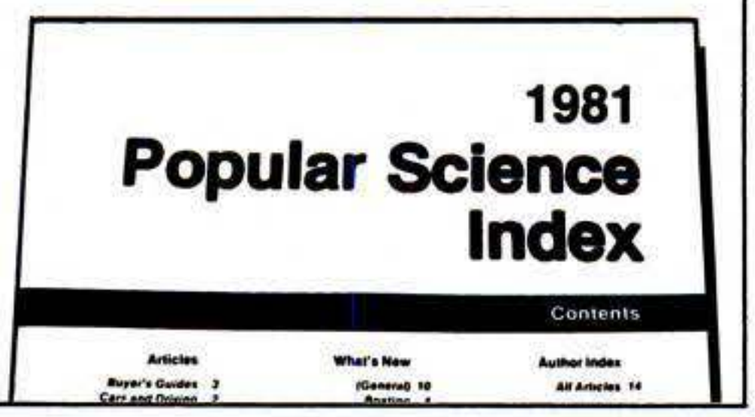

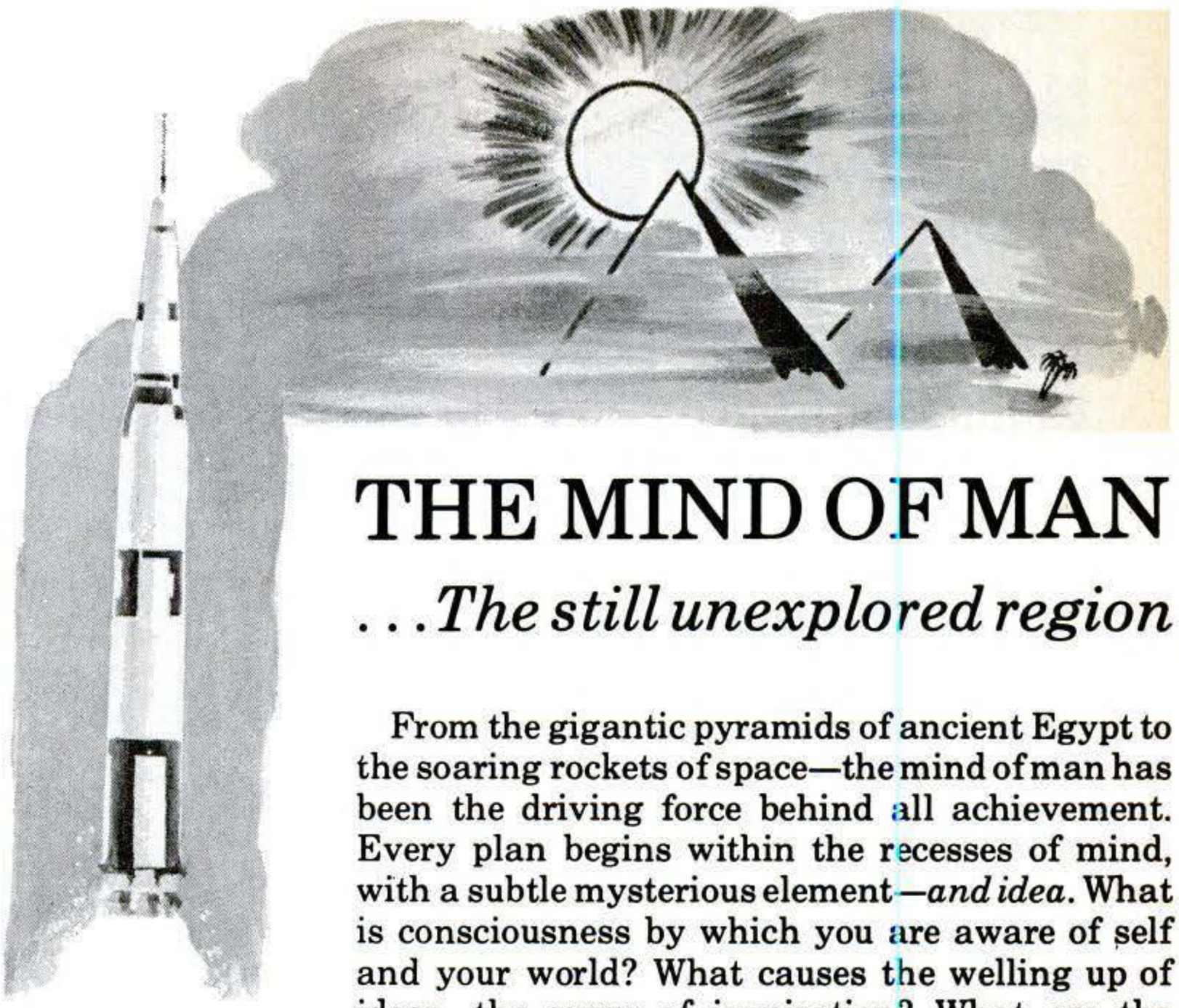

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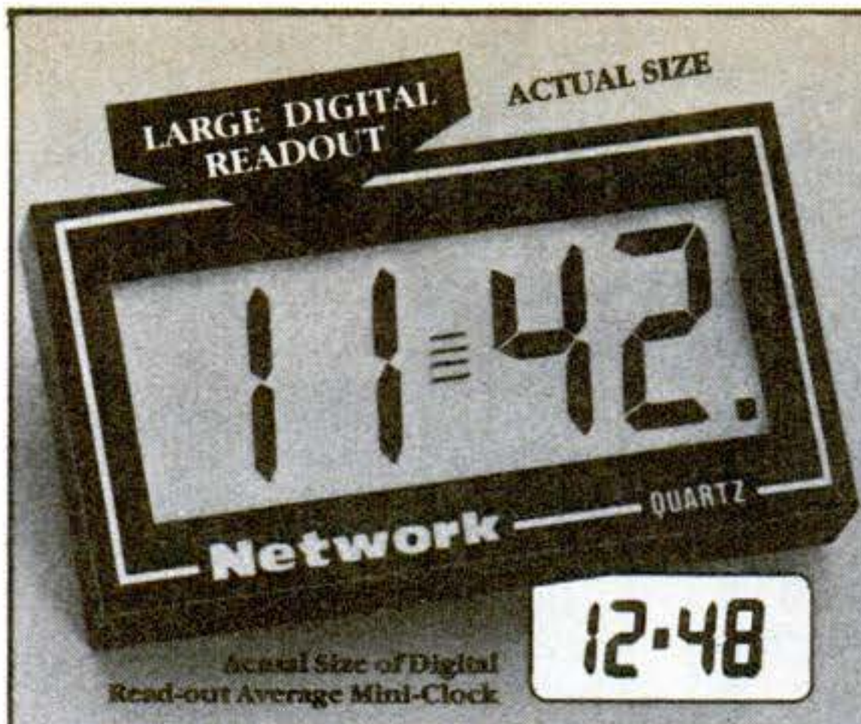

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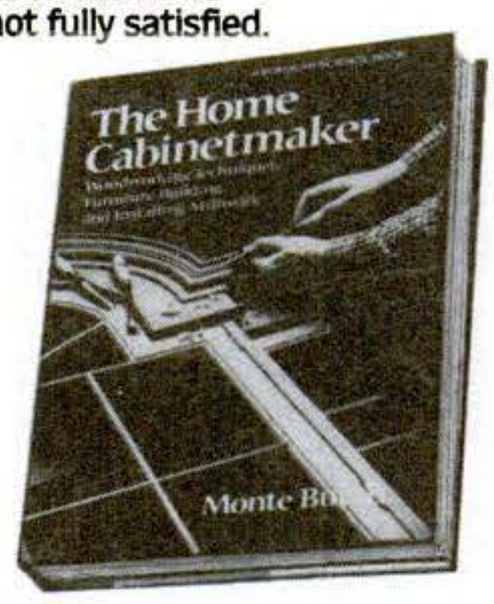

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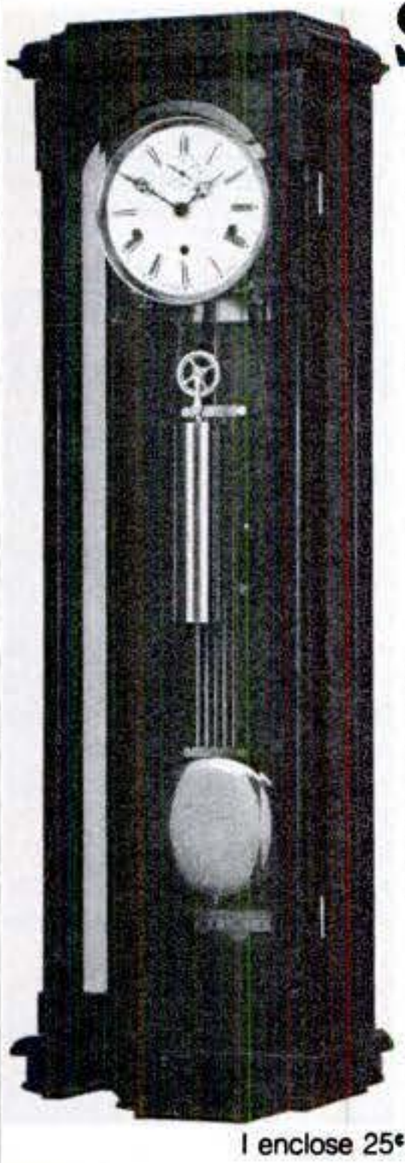

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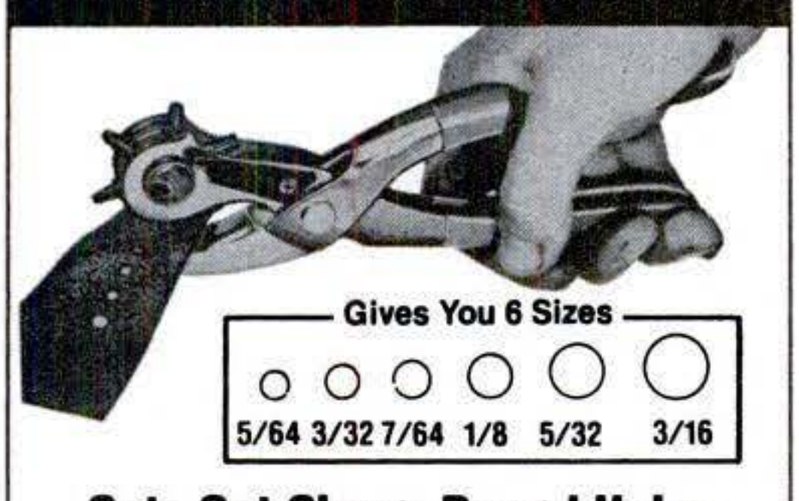

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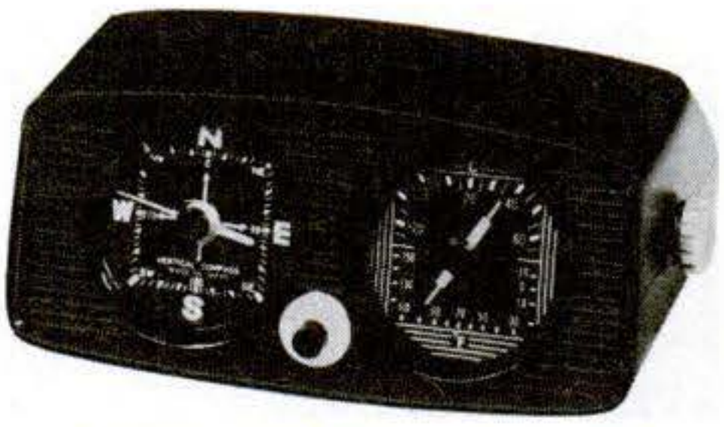

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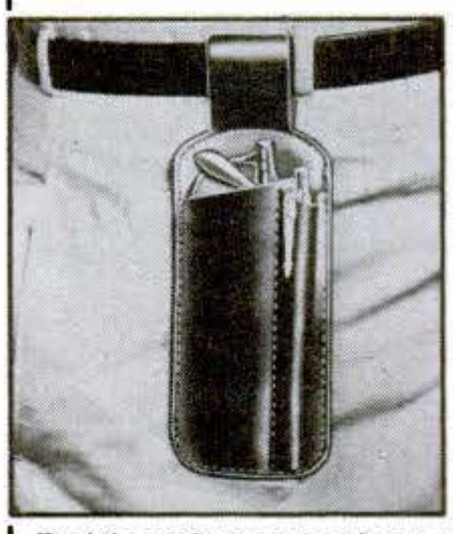

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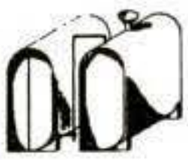

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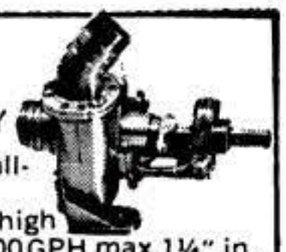

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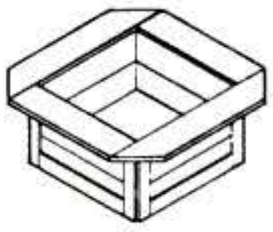

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Booklets, catalogs, and folders listed below provide reliable information, illustrations, and specifications to help you in planning the purchase of a variety of products or services offered by these dependable companies. The convenient order form will save you time and postage.

901 Personal Computers Catalog describes Arcsoft Publishers' line of books for beginners in hobby, home, school, and business computers, as well as books of projects for electronics hobbyists. Free

902 Redwood Paneling A step-by-step guide to redwood-lumber wall paneling includes photos, diagrams, and detailed text for vertical, horizontal, and diagonal designs for any room. Purchasing information, materials lists, necessary tools, and finishing are all detailed. From California Redwood Assn. 35¢

903 Home Building This 52-page full-color catalog, "Today's Most Affordable Home Building Program," makes owning a home possible now. Curtis Homes provides the construction, materials, and credit. $2

904 Aircraft through the Ages Leaflet from Carbooks describes and illustrates its full-color, framed prints of the most famous fighter aircraft from World War I to the present. Includes Fokker D VII, Spad, Boeing F4B-4, Spitfire, Mustang, Phantom, Harrier, F-16, and many more. 25¢

905 Money-Saving Vehicles Color brochure from Carl Heald, Inc., describes vehicles you build from kits. It includes trail bikes, three- and four-wheel ¼-ton trucks, tillers, log splitters, and row-crop adapters. Free

906 Rugged Pickup Trucks This full-color brochure from Toyota features its tough, dependable trucks—everything from from sporty SR5's to rugged 4×4's. Free

907 Self-Employment Handbook "Financial Independence . . . The Datsun Guide to Bootstrap Business" is a 100-page guide explaining how to go into business for yourself. It suggests over 20 full- or part-time activities you can organize in your community to make money. $2

908 Compact Power-Tool Guide This book tells how to get the most out of Moto-Tools as well as all other Dremel power tools, attachments, and accessories. It contains hundreds of illustrations, patterns, and projects. Ideal for the beginner or advanced power-tool user. $7.95

909 Solar Greenhouse Catalog describes how to reduce home-heating costs by collecting solar energy in beautiful sunspaces. Do-it-yourself kits include triple-glazed, factory-insulated aluminum frames with bronze-tone enamel finish. From Four Seasons Solar Products. $1

910 Woodworking Tools Garrett Wade's illustrated 212-page catalog describes the finest woodworking tools and finishing supplies—for pros and hobbyists who want the best. $3

911 Mid-Size Tractors This color brochure has complete information on Mitsubishi's line of mid-size tractors. Ideal for gardeners, gentleman farmers, or grounds maintenance. Free

912 Personal-Care Showers Turn your bathroom into a spa with a system that bubbles, tingles, and pulsates. It adjusts to anybody's height and has water- and energy-saving features. Details from Interbath, Inc. 25¢

913 Recreational Vehicles Literature from Jayco, Inc., shows its selection of recreational vehicles. Complete floor plans, specifications, and construction features are included for tent campers, fifth wheels, pickup-truck campers, mini motor homes, van conversions, park trailers, and three lines of travel trailers. Free

914 Read Faster, Remember More Leaflet describes Learn Inc.'s Super Reading System, the book and cassette course that can increase your reading speed and comprehension by more than 100 percent. Super Reading focuses on the thinking skills of reading—not just on eye movement. Free

915 Ventilation Tips "The In's and Out's of Ventilation" describes the causes and effects of inadequate ventilation and explains what the consumer can do to properly ventilate his house. From Lomanco. Free

916 Energy-Efficient Heating A brochure from Arkla shows how the new, patented Arkla Recuperative Gas Furnace saves energy costs by reducing fuel consumption. The company says the heating system will pay for itself in savings. Free

917 Industrial and Agricultural Accessories Discount booklet from Northern Hydraulics describes log-splitter parts, hydraulic pumps, cylinders and controls, 3½- to 16-hp gasoline motors, portable generators, trailer parts, go-carts, mini bikes, and wheel parts. Free

918 Electronics Comic Book The Science Fair Story of Electronics features space exploration, energy, history, and new developments in electronics. It's a full-color educational comic for elementary-school students. From Radio Shack. Free

919 Air Filters Information on in-the-home air-pollution control is provided in a new booklet, "Cleaner Air." It describes the capabilities of air filters and air cleaners and presents efficiency data on the removal of house dust, tobacco smoke, pollens, and spores by a new type of air cleaner that uses no electricity. From Research Products Corp. Free

920 Window and Door Ideas This 24-page color booklet from Pella/Rolscreen describes wood and aluminum-clad windows and patio doors plus skylights, sun rooms, and interior wood folding doors for traditional and contemporary homes. Energy-saving design, glazing options, and low-maintenance features are illustrated and described. Free

921 Save on Heating Costs "The Woodmaster Primer" is a descriptive pamphlet from Suburban Manufacturing on how to save on home-heating costs by burning wood rather than oil and electricity. Free

922 Computer Books This catalog profiles and rates the technical experience required for readers of Sybex computer books. The books are available in nine languages. Free

923 Security Vest This vest is worn under clothing for greater personal security. It's pick-pocket-proof, imperceptible, lightweight, and machine washable. Secured pockets hold credit cards, currency, travelers' checks, tickets, and passports. A leaflet from Travel Safvest describes it all. Free

924 Tools, Tools, and More Tools! All 196 pages of this U.S. General Supply Corp. catalog are filled with top-name tools and supplies. It includes over 6,000 items essential for car care and maintenance, interior and exterior home improvement, wood- and metal-working, and plumbing and electrical projects. Discounted prices, too. $1 (refundable on first order)

925 Fly Your Own Plane without a License A special report from Ultralight features its new, inexpensive airplanes you can fly from your back yard. It reviews various makes, including costs, and tells how you can get into the sport. Free

926 Moving Guide A 28-page moving guide from U-Haul is available for cost-conscious families planning a do-it-yourself move. The booklet includes a valuable plan-your-move chart. Free

927 Woodworking and Handicraft Ideas A 112-page booklet, entitled "Patterns for Better Living," illustrates and describes almost 700 woodworking and handicraft project ideas. Plans and patterns feature step-by-step directions. From U-Bild. $1.95

928 Woodworking Supplies This 112-page full-color catalog of quality woodworking supplies includes veneers, hardware, hinges, specialty hardware, stains, books, plans, and much more. From the Woodworkers' Store. $1

929 Power Washer Literature describes the new Thunder Gun power washer. Attach it to a one-hp or larger air compressor and a garden hose to clean, degrease, or spray with an over-300-mph blast of water and air. From Briar Industries. Free

930 Government Surplus Hard-to-get items for hobbyist, mechanic, or sportsman are described in the 1982 Airborne Surplus Catalog. Bargains include savings of up to 90 percent on government surplus. $1 (refundable on first order of $10 or more)

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THIS COUPON EXPIRES NOVEMBER 30, 1982

Note: POPULAR SCIENCE Massachusetts address is for Product Information only. Subscription inquiries should be directed to the address at the foot of the table-of-contents page.

Please send the items checked below. I am enclosing $1 handling charge (any number of items) plus amount required for priced items.

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POPULAR SCIENCE SEPTEMBER 1982

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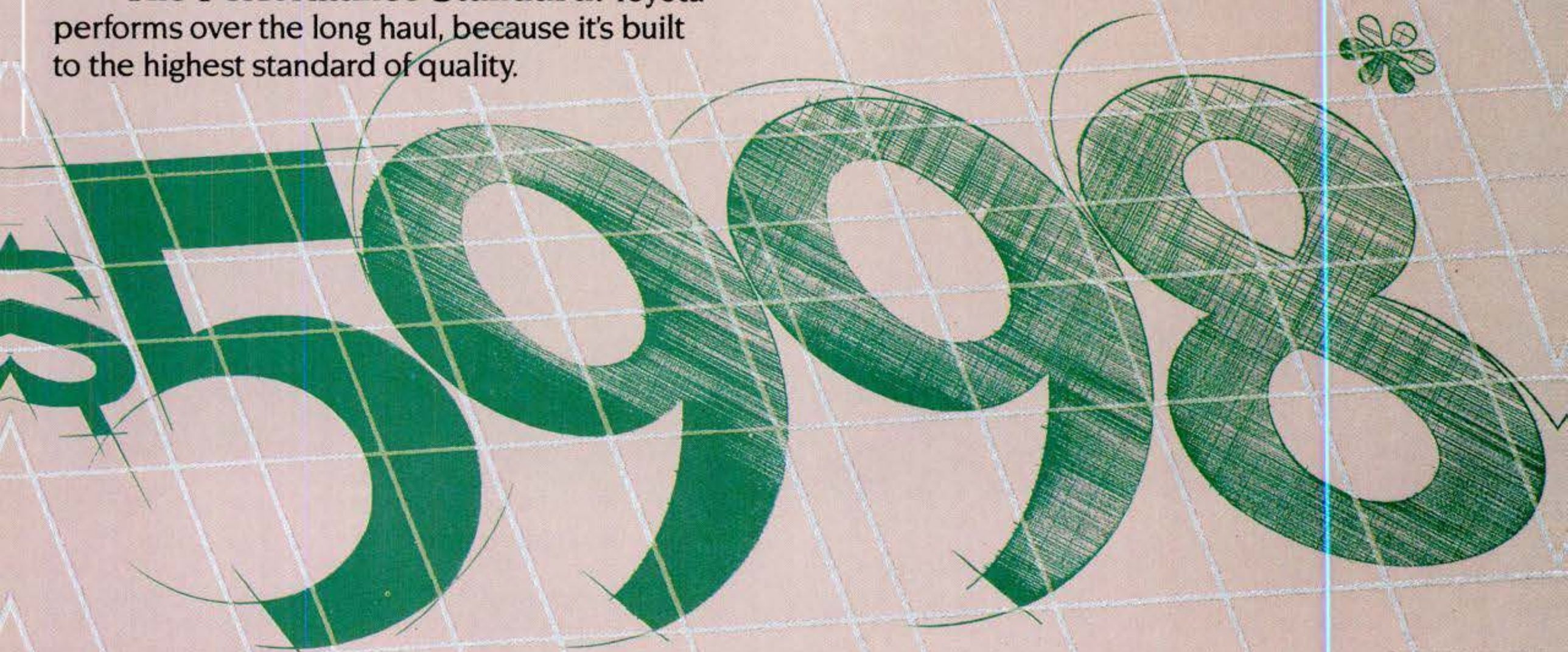

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